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USING YOUR MIND TO TRAIN YOUR BODY: AN EXPERIMENTAL AUTOBIOGRAPHICAL MEMORY INTERVENTION FOR ADOLESCENT PHYSICAL ACTIVITY

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FOR ADOLESCENT PHYSICAL ACTIVITY

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DEDICATION

I would like to dedicate this dissertation to my wife, Erin, and to our lovely dogs, Quincy and Chiara (A.K.A. the kids), for always supporting me, for providing me a source of positive motivational memories, and for being goofy at all the right times.

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ABSTRACT

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Developmentally, physical activity levels tend to decline from adolescence to early adulthood. Adolescent physical activity programs have been largely ineffective, leading to a call for new low-cost interventions. This study examined the effects of an autobiographical memory intervention on adolescent physical activity. Over six weeks, students ($N = 558$) in a New England middle school completed questionnaires and were timed weekly in physical education classes while training for a school-wide race. During Week Three, some students were asked to provide a positive motivational physical activity memory and others a control memory. Students indicated their intentions to be physical active, completed self-reports of physical activity, and were given the option to attend a physical activity session after school. Students in the motivational memory condition indicated greater physical activity intentions and ran faster training runs immediately following the intervention. A marginal effect of the memory intervention was also observed on race day running times. No effect was observed on self-reported physical activity or attendance at the optional activity. This study advances our knowledge of the directive effect of autobiographical memory on objectively measured behavior, showing that memories can direct health behaviors in adolescence.

PHYSICAL ACTIVITY IN ADOLESCENCE

From a public health perspective, identifying factors that motivate individuals to engage in regular physical activity is vital. Worldwide, 39% of adults 20 years of age and older were overweight as of 2013 and 13% were obese (World Health Organization [WHO], 2015). The obesity epidemic is especially serious in the United States, where more than one-third of adults 20 years of age and older are obese (Centers for Disease Control and Prevention [CDC], 2012a) as are approximately 17% of children ages 2 to 19 (CDC, 2012b).

Childhood obesity can have long-term negative consequences: Overweight children are six times more likely than other children to become overweight adults (Herman, Craig, Gauvin, & Katzmarzyk, 2009). Furthermore, only 18% of adolescents met the U.S. Department of Health and Human Services recommendations of 60 minutes of moderate-to-vigorous physical activity daily as of 2007 (CDC, 2011a). Adolescence is a critical juncture for reversing obesity trends and establishing lifelong physical activity patterns as these patterns may be most susceptible to intervention efforts before early adulthood (Herman et al., 2009). Even if children are highly active there is ample evidence to suggest that physical activity levels decrease over the course of adolescence (Brownson, Boehmer, & Luke, 2005; Sallis, Prochaska, & Taylor, 2000; Trost et al., 2002). Biddle, Gorely, and Stensel (2004) suggest these decreases might be related to the transition to secondary school, which introduces many barriers to exercise for young people including the threat of embarrassment due to body-image concerns and lack of time due to greater scholastic demands.

Interventions to boost the physical activity of adolescents may not be sufficient to prevent obesity on their own; however, effective obesity prevention programs in adolescence should benefit from a physical activity promotion component (Goran, Reynolds, & Lindquist, 1999; Staniford, Breckon, & Copeland, 2012). Physical activity interventions in adolescence may convey benefits beyond potential obesity prevention as there are many other well-documented benefits for adolescents to being physically active throughout the lifespan. There are immediate benefits for adolescents in terms of self-image, self-esteem, and psychological well-being (Biddle & Asare, 2011; Kirkcaldy, Shephard, & Siefen, 2002) and evidence suggests that these early benefits persist into adulthood (Malina, 2001; Sacker & Cable, 2006). Unfortunately, knowledge of the benefits of a healthy lifestyle does not seem to be adequate to overcome the barriers to such a lifestyle that many adolescents perceive (O'Dea, 2003).

The process of becoming physically active is complex and associated with many psychological, social, physical, and environmental factors including perceived enjoyment (Allender, Cowburn, & Foster, 2006; Dishman, Jackson, & Bray, 2014; Zhang, 2009), family/friend support and parental physical activity (DiLorenzo, Stucky-Ropp, Vander Wal, & Gotham, 1998; Eliakim et al., 2002; Graham, Wall, Larson, & Neumark-Sztainer, 2014; Sallis et al., 2000; Van der Horst, Paw, Twisk, & Van Mechelen, 2007; Van Slujis, McMinn, & Griffin, 2007), body-image and weight concerns (Markland & Ingledew, 2007; Neumark-Sztainer, Paxton, Hannan, Haines, & Story, 2006), access to or layout of facilities (Sallis et al., 2000; Stratton, 2000), self-efficacy (Berry, Naylor, & Wharf-Higgins, 2005; Dishman et al., 2014; Graham et al., 2014; Olander et al., 2013), and motivation (Gillison, Standage, & Skevington, 2006, 2011; Standage, Gillison, Ntoumanis, & Treasure, 2012; Standage, Sebire, & Loney, 2008; Taylor, Ntoumanis, Standage, & Spray, 2010; Ullrich-French & Cox, 2014; Van der Horst et al., 2007; Zhang, 2009). The effects of many of these factors may differ in adolescence from other periods of life (Biddle et al., 2004) and extant interventions do not agree on what is effective for promoting adolescent physical activity (Olander et al., 2013; Sims, Scarborough, & Foster, 2015; Stice, Shaw, & Marti, 2006).

Thus, interventions focused on physical activity in adolescence may demand innovative delivery techniques and novel behavioral maintenance strategies. An examination of the interventions that have been done to date may indicate where improvements can be made to better the effectiveness of future intervention efforts and also what factors may demand further examination.

Adolescent Physical Activity Interventions

Popular models of behavior change characterize the progression from sedentary to regularly physically active as an iterative process that involves a series of qualitatively distinct stages (Prochaska & DiClemente, 1983; Prochaska & Norcross, 2001) or as progression along a continuum representing the likelihood of undertaking an action (Ajzen, 1991; Schwarzer, 2008; Sutton, 2008). Interventions designed to influence physical activity often endeavor to affect social-cognitive mediators of physical activity; through the change in mediating variables they hope to promote sustained physical activity (Bandura, 2004; Chatzisarantis & Hagger, 2009; Parschau, et al., 2012; Plotnikoff, Costigan, Karunamuni, & Lubans, 2013; Sutton, 2008). Although no single model is accepted as the best model of behavior change, intervention efforts have been shown to benefit from a solid theoretical background (Gourlan et al., 2015).

Existing obesity prevention and physical activity promotion interventions for children and adolescents have largely been laborious, large in scale, and of questionable long-term effectiveness (Haynos & O'Donohue, 2012; Metcalf, Henley, & Wilkin, 2012; Sims et al., 2015; Staniford et al., 2012; Stice et al., 2006). Extant interventions have used a variety of methodologies in order to effect health-promoting behavior change in children and adolescents with disappointing results. For example, although it has been recommended that health-promoting interventions aimed at youth involve the school (Kriemler et al., 2013; Van Sluijs et al., 2007) and the family (Biddle et al., 2004; DiLorenzo et al., 1998; Eliakim et al., 2002; Sallis et al., 2000), school-based physical activity interventions on their own have not been consistently effective at improving physical activity (Harris, Kuramoto, Schulzer, & Retallack, 2009; Sims et al., 2015) and, despite evidence suggesting that the addition of parental or family involvement in school-based interventions may improve their effectiveness (Bandura, 2004; Graham et al., 2014; Van Slujis et al., 2007; Roesch et al., 2009), many of these interventions are also hindered by the large cost of administration and time commitment of family members (Kitzman-Ulrich et al., 2010). Regardless of the theoretical underpinnings and methods of delivery of interventions, setbacks and relapse tend to be the rule and not the exception as the majority of people will regress to prior behavioral states and struggle to maintain behavioral change (Marcus et al., 2000).

Researchers have called for the development of new low-cost interventions involving strategies for maintaining intervention effectiveness (Staniford et al., 2012). Maintaining one's motivation to continue to be physically active may be important for sustaining intervention effectiveness for adolescents in particular. Biddle et al. (2004) and others suggest that the unique psychosocial challenges faced by adolescents may sap their motivation to be physically active and contribute to declining physical activity levels in adolescence; however, maintaining one's motivation throughout this period may mitigate or altogether prevent such a decline (Gillison et al., 2006, 2011; Markland and Ingledew, 2007). Thus, adolescent physical activity interventions could benefit from the inclusion of training in motivational maintenance strategies. In order to identify promising new avenues for research on strategies that can help children maintain intervention effects, it is important to examine current models of behavior change and what theoretically important strategies have already been examined.

Predictors of Behavior Change and Physical Activity Maintenance

Popular behavior change models such as Social Cognitive Theory (SCT: Bandura, 2001), the Theory of Planned Behavior (TPB: Ajzen, 1991), and Self-Determination Theory (SDT; Deci & Ryan, 1985) have had limited success in predicting behavior maintenance (Armitage, 2005; Jekauc, et al., 2015), as have stage-based theories of behavior change such as the Transtheoretical Model of Behavior Change (TTM: Prochaska & Diclemente, 1986; Rhodes & Nigg, 2011) and the Health Action Process Approach (HAPA: Parschau et al., 2012; Sutton, 2008). Each theory posits several theoretical determinants of behavior change that may be targeted by interventions to influence behavior change and behavior maintenance.

According to SCT, an individual's efforts to effect and maintain health behavior change are determined by their knowledge of health risks and benefits, their perceived self-efficacy for enacting change, their outcome expectancies related to specific health behaviors, their goals, the strategies they use to realize those goals, and facilitators and impediments of change they perceive in the environment (Bandura, 2004). The theory posits that perceived self-efficacy can affect behavior both directly and indirectly through its effect on the other determinants of behavior (mediation through outcome expectancies, goal setting, etc.). An offshoot of SCT, Self-Efficacy Theory (SET; Bandura, 1994) posits that past performance accomplishments are a significant source of self-efficacy. Bandura (2004) suggests any successful health promotion intervention ought to include a self-efficacy component and behavior change research supports the importance of self-efficacy in predicting intervention outcomes (Palmeira et al., 2007).

Although SCT does not specifically suggest self-regulatory strategies that may be useful to realize one's goals, such strategies are considered important for maintaining change and persisting in goal pursuit as they allow individuals to monitor their progress towards the goals they set. In addition to including self-efficacy, Bandura (2004) suggests health promotion interventions be tailored to an individuals' self-management abilities.

An indication of self-regulatory strategies that might aid long-term maintenance of health behavior change can be found in an SCT intervention that taught self-regulatory strategies such as self-monitoring, goal-setting, using feedback, and soliciting social support to accompany normal, prescribed treatment to manage cardiac problems (DeBusk et al., 1994). In-patients hospitalized for acute myocardial infarction received interventions for smoking cessation, exercise training, and diet-drug therapy from trained clinicians. In addition to treatment and normal follow up, patients in the experimental SCT intervention group received instruction in setting attainable goals, monitoring progress with self-reports of their health behavior, and were followed by a case manager outside of the clinical setting through intermittent telephone check-ups, short in-person checkups, and mailed check-ups. They also received occasional progress reports to help assess their goal attainment and could meet with a counselor if a smoking relapse occurred as an additional social support. At 12-months following the intervention, those receiving the experimental case management along with prescribed treatment showed greater improvement in their health than participants in a prescribed, self-managed control group.

The greater contact with a care provider in the experimental group may be a confound in this study and findings may not generalize beyond cardiac in-patients; however, the design of the intervention suggests what SCT-derived self-regulatory strategies might be used for health behavior change and maintenance. Recalling memories of past physical activity accomplishments may be another self-regulatory strategy that may augment one's self-efficacy regardless of current levels, thereby supporting physical activity maintenance.

According to the TPB, intentions to partake in behaviors along with perceived behavioral control to perform the behavior (similar to self-efficacy) directly predict the likelihood an individual will partake in a behavior (Ajzen, 1991). Intentions can be roughly equated to the individual's motivation for a particular behavior, and these are predicted by attitudes toward the behavior, perceived norms regarding the behavior (how important others might react to one performing the behavior), and also by perceptions of behavioral control. Perceptions of behavioral control are determined by salient beliefs that are held by the individual when deciding to act or not to act (i.e. how difficult a behavior will be). The TPB does not directly predict what self-regulatory strategies may be used to best manage behavior, but since the TPB has been much more useful in predicting intentions than predicting behaviors, researchers suggest that self-regulatory strategies may mediate the path between intentions and behavior (Bagozzi, 1992; Sniehotta & Schwarzer, 2005).

According to SDT (Deci & Ryan, 1985; Ryan & Deci, 2000), individuals are motivated to engage in various behaviors to the extent that they meet their needs of competence, autonomy and relatedness. A broad distinction has been made between autonomous forms of motivation and controlled forms of motivation. These two motivational types differ in terms of the degree to which they are internally or externally determined. Autonomous regulation is related to high intentions to exercise and to greater exercise behavior (Stanley, Cumming, Standage, & Duda, 2012; Teixeira, Carraça, Markland, Silva, & Ryan, 2012), whereas controlled regulation is not as predictive of exercise behavior (Standage et al., 2008).

SDT constructs have been effective at predicting adolescent physical activity (Taylor et al. 2010; Sebire, Jago, Fox, Edwards, & Thompson, 2013; Standage, Duda, & Ntoumanis, 2003; Standage et al., 2012), but as mentioned previously, motivational changes associated with entrance into secondary school may underlie decreases in physical activity in adolescence (Biddle et al., 2004; Markland & Ingledew, 2007; Ullrich-French & Cox, 2013). Promoting autonomous forms of motivation in adolescents may bring about positive physical activity changes as autonomous motivation is theorized to increase task persistence (Ryan & Deci, 2000; Ryan, Patrick, Deci, & Williams, 2008) including persistence in physical activity (Ryan, Williams, Patrick, & Deci, 2009; Teixeira et al., 2012). Many studies with adults support the idea that increases in autonomous regulation can bring about change in physical activity (Andersson & Moss, 2011; Lewis & Sutton, 2011; Rodgers, Hall, Duncan, Pearson, & Milne, 2010; Standage et al., 2008; Stanley et al., 2012).

Efforts to increase physical activity through an SDT framework are, like physical activity interventions in general, often laborious and ineffective. For example, successful adult interventions aimed at influencing exercise behavior from an SDT perspective have typically employed explicit instruction or counseling over several sessions (Fortier, Sweet, O'Sullivan, & Williams, 2007; Silva et al., 2010). SDT interventions targeting adolescents often involve the manipulation of the school physical education environment over several weeks or more to promote the satisfaction of the three psychological needs that underlie motivational change as a means of influencing physical activity (Chatzisarantis & Hagger, 2009; Harris et al., 2009; Perlman & Goc Karp, 2010), but even long-term motivational interventions may not bring about motivation change in adults (Webber, Gabriele, Tate, & Dignan, 2010) or adolescents (Wilson et al., 2002).

Another health behavior framework that has been useful for predicting physical activity is the Transtheoretical Model of Behavior Change (TTM; Prochaska & DiClemente, 1986). This model combines constructs from other theories of behavior change (Prochaska, 2008). The theory posits that behavior change does not result from a one-time decision, but instead from the progression through five stages (Norcross, Krebbs, & Prochaska, 2011). Similar to Bandura's (2004) suggestions with SCT interventions, TTM interventions ought to be tailored to match the current stage of the individual to best influence behavioral change (Norcross et al., 2011; Prochaska & Norcross, 2001). Within each stage, the theory posits that three constructs can predict and influence behavior change: self-efficacy, decisional balance (the strength of perceived pros and cons related to change), and processes of change (the strategies and techniques used to bring about behavior change) (Marshall & Biddle, 2001). This model has been shown to add to the value of other models to predict physical activity (Ingledew, Markland, & Medley, 1998; Mullan & Markland, 1997); however, the model as a whole has not been consistently effective at predicting behavior (Nigg, 2001; Spencer, Adams, Malone, Roy, & Yost, 2006). In physical activity research with adolescents, the constructs of self-efficacy and decisional balance have been most helpful in predicting behavioral change (Berry et al., 2005; Lubans, Foster, & Biddle, 2008; Maddison & Prapavessis, 2006; Munroe-Chandler, Hall, Fishburne, Murphy, & Hall, 2012; Taymoori & Lubans, 2008).

A growing body of research has drawn a distinction between the behavioral adoption and the maintenance stages of behavior change. Studies suggest there may be different social-cognitive determinants of behavior maintenance than of behavior adoption, highlighting the potential need for qualitatively distinct models of adoption and maintenance and interventions matched to the stage of behavior change (Fuchs, Seelig, Göhner, Burton, & Brown, 2012; Nigg, Borelli, Maddock, & Dishman, 2008; Parschau, et al., 2012). Physical Activity Maintenance (PAM) theory was developed by Nigg and colleagues (2008) to explicitly predict physical activity maintenance. This theory posits that goal-setting, self-motivation (the general characteristic of being able to motivate oneself in a variety of situations), and self-efficacy are reciprocal influences that interact with the environment to effect behavior maintenance. This is the first comprehensive theory that pertains specifically to behavior maintenance. It combines known predictors of physical activity from several prominent theories to specifically posit what personality traits predict maintenance, what strategies may be used to successfully prevent relapse, and how contextual variables can enhance or inhibit an individuals' use of maintenance strategies. Although the constructs included in this theory are putatively related to other behavior change theories, PAM theory has not yet improved upon the predictive power of the theories that inspired its development, leading once more to the suggestion that volitional strategies, those used to maintain our effort, are in need of further study (Amireault, Godin, & Vézina-Im, 2013; Jekauc, 2015).

In terms of those characteristics and self-regulatory strategies that predict maintenance of behavior change, long-term maintenance has also been predicted by self-efficacy (Armitage, 2005; Dishman et al., 2014; Parschau et al., 2012). Additionally, in their study of self-regulatory processes theorized in the TTM, Dishman and collegues (2014) found that adherence to an exercise regime (gym attendance) was predicted by self-regulatory strategy use; however, compliance with the regime (measured as amount of prescribed exercise performed at each gym session) was not predicted by self-regulatory strategies but instead by self-efficacy and enjoyment of exercise. The young adults in this study used cognitive and behavioral self-regulatory strategies in order to attend prescribed exercise sessions, but their effort at the gym was not influenced by their use of particular self-regulatory strategies. These studies suggest self-efficacy may be just as important to long-term behavior maintenance as it is to behavior change and may be related to self-regulatory strategy use; however, they too have been conducted in adult populations and in non-experimental settings and therefore do not necessarily generalize to and advance our knowledge of self-regulatory strategy use by adolescents in the context of physical activity interventions.

In an attempt to better understand the social-cognitive mediators of health-behavior change in adolescents, Dishman and colleagues' (2005) had a sample of adolescent girls complete questionnaires of self-efficacy, outcome expectancies, and other social-cognitive predictors of physical activity. Included was a questionnaire regarding cognitive and behavioral self-management strategies used as motivation, such as goal setting and thinking about the benefits of exercise. The use of these self-management strategies was predictive of self-reported physical activity; however due to the correlational nature of this study, it is unknown how experimental manipulation of self-management strategies would affect future physical activity. Additionally, the reliance on a forced-choice self-report measure of self-management strategies that had been adopted from a measure used for young adults does not elucidate whether the strategies measured are those used most often or that are found to be most effective by adolescents. It is likely adolescents could benefit from the use of strategies not traditionally considered self-management strategies.

Whereas there are no experimental studies we know of examining self-regulatory strategies for physical activity in typical adolescent samples, evidence from studies of adolescent behavioral self-regulation in academic contexts and with clinical samples of adolescents suggest self-regulatory strategies can be taught to adolescents and continue to affect behavior.

Zimmerman (2008) describes interventions wherein teachers have successfully taught self-regulatory skills to their elementary school students that have translated into improved study skills and better learning outcomes. In addition, one study directly investigated if self-regulatory strategies could help improve the health of obese children in the context of a standard, multi-component, family obesity intervention (Israel, Guile, Baker, & Silverman, 1994). Over 26-weeks of in-clinic educational intervention, some child-parent pairs were given treatment as usual and the parents were primarily responsible for following the program guidelines, whereas other children had the intervention with an increased emphasis on personal self-regulation (goal-setting, planning, self-evaluation, self-reward, and problem-solving for high risk scenarios). Both interventions were effective in the short term, but evidence suggested the self-regulation group had better body fat percentage as long as three years post-treatment. In addition, scores on measures of self-regulation improved during treatment for both groups and improvement in self-regulation was correlated with better outcomes during treatment. Unfortunately, these results were plagued by low power, and the omission of measures of physical activity or other specific behaviors leaves to question what effect the intervention may have had on behavior. In addition, the self-regulatory strategies taught to the adolescents were many of the same strategies utilized in adult populations. Although qualitative inquiry has not further illuminated what unique self-regulatory strategies typical adolescents may use for maintaining physical activity (Ketteridge & Boshoff, 2008), these studies support that adolescents can be taught self-regulatory strategies to improve health behavior.

The above self-regulatory interventions are promising but still involve long-term interventions, costly administration, and do not include objective measures of health behavior; however, at least one study suggests that brief interventions can effectively teach self-regulatory strategies to adolescents and influence their physical activity. Schwarzer, Sheng Cao, and Lippke (2010) tested the effects of two physical activity interventions that were matched to participant stages of change as measured according to the HAPA in Chinese middle schools. Both interventions were designed for administration in approximately one hour to large groups of adolescents. Adolescents who did not intend on becoming physically active received an instructional intervention about the pros of physical activity and the cons of physical inactivity and were encouraged to engage in more physical activity. Adolescents who indicated they were thinking of becoming more physically active, but who had not decided to engage in physical activity, received an intervention that instructed self-regulatory strategies through the creation and use of action plans. Adolescents predicted specific barriers that could impede physical activity and created plans on how, when, where, and with whom they could be more physically active as well as ways they could cope with specific barriers that may arise. These stage-matched interventions were shown to increase self-reported physical activity over a four-week span, but still little is known about the effects of brief self-regulatory interventions on objectively measured adolescent physical activity.

The proposed study will examine the effectiveness of an intervention that uses one's own memories of past experiences as a means of motivational maintenance on objectively measured physical activity in adolescence. To date I know of no research that directly examines the use of one's own memories as motivation in an adolescent population; however, prior research on imagery, affect, and autobiographical memory support the prediction that self-reported and objectively measured physical activity will be increased in an adolescent sample by the activation of positive memories of a past physical activity experience.

Imagery and Affect Studies

Research examining the effect of imagery and exercise-related affect suggests that activating autobiographical memories could elevate exercise behavior. Researchers have examined imagery as a form of motivational facilitation that is frequently used by high-achieving athletes (Driskell, Copper, & Moran, 1994; Gregg, Hall, & Nederhof, 2005; Jones & Stuth, 1997; Martin, Moritz, & Hall, 1999; Ross-Stewart & Short, 2009). Additionally, imagery may be used to improve exercise-related affect (Stanley & Cumming, 2010), exercise motivation (Andersson & Moss, 2011; Duncan, Hall, Wilson, & Rodgers, 2012; Hall, Rodgers, Wilson, & Norman, 2010), and exercise behavior (Andersson & Moss, 2011; Chan & Cameron, 2012; Cumming, 2008).

Although much of this research has been conducted with adults (eg. Stanley et al., 2012), at least one study has demonstrated the effectiveness of an imagery intervention for children as young as 7 years old to increase athletic ability (Munroe-Chandler et al., 2012), and researchers are now examining the use of imagery as a tool to motivate physical activity in children and adolescents (Cooke, Munroe-Chandler, Hall, Tobin, & Guerrero, 2014). As common cognitive mechanisms and neural structures have been found to underlie both episodic memory and self-referential imagination (Buckner & Carroll, 2007; Schacter & Addis, 2007, 2009), and one source of exercise imagery may be relevant past experiences (Chan & Cameron, 2012; Giacobbi, Hausenblas, Fallon, & Hall, 2003; Stanley & Cumming, 2010), the activation of relevant personal memories could also influence the motivation to be physically active and affect adolescent physical activity in a similar way to that observed with the use of imagery.

Another memory-relevant focus in studies examining exercise behavior is the role played by affect. Kwan and Bryan (2010) examined individuals' affective responses to aerobic exercise before, during and after an exercise episode. They found that people who responded with more positive and less negative affect reported more favorable exercise attitudes, greater exercise self-efficacy, and greater intentions to exercise. These positive emotional reactions could exert their future influence through re-activation in memory. Similarly, Parfitt and Hughes (2009) suggested that one's affective response during and immediately following an exercise episode is a good predictor of subsequent behavior. The authors speculated that lingering memories of positive emotions could promote exercise persistence. The link between affect and physical activity is not as well studied in adolescent samples, but a recent study suggests physical feeling states (feeling energetic) may promote physical activity, which in turn may promote positive affect (Dunton et al., 2014). It is possible adolescents may also benefit from the positive affect of memories of being physically active to motivate subsequent physical activity.

Directive Function of Autobiographical Memory

There is a wide body of experimental literature examining the influence of autobiographical memory on many different behaviors, suggesting that memory should play an important role in influencing exercise activity. Memories of past experiences guide current and future behaviors, intentions, and problem solving (Bluck, 2003; Bluck, Alea, Habermas, & Rubin, 2005; Pillemer, 1998, 2003, 2009; Schacter, Addis, & Buckner, 2007). Research has shown that memories of particular episodes are influential in motivating behavior even when controlling for the effects of general attitudes (Kuwabara & Pillemer, 2010; Philippe, Koestner, & Lekes, 2013).

Kuwabara and Pillemer (2010) found that undergraduates reported greater intentions to give a donation to their university after recalling a positive episode concerning their university, and that this effect was evident even when controlling for prior attitudes toward the university. Moreover, when given the option to donate real money to their university or to an unrelated charity, those students who had recalled positive episodes chose to give to their university significantly more often than students in a control condition, with students who had recalled negative episodes falling in-between. On a related topic, Beike, Adams, and Naufel (2010) found that the amount of closure associated with a personal memory—the degree to which the remembered event represented "unfinished business"—affects giving behavior: Remembering low-closure episodes of failure to donate to a charity led to increased giving behavior.

Pezdek and Salim (2011) examined the directive impact of personal memories on public speaking performance. Individuals who activated a memory of a past successful public speaking experience had diminished anxiety (measured by self-reports and cortisol levels) during a subsequent public speaking task in comparison to individuals who were asked to activate a memory of a past success dealing with an unrelated phobia and performed better at the task when judged by blinded observers. The authors' theoretical explanation for the effects of specific autobiographical memories on behavior centered on the activation of relevant aspects of the self-concept related to public speaking. In the current study, remembering a positive physical activity memory could temporarily activate a more positive physical activity-related self-concept, which would then lead to an increase in physical activity.

Recently, research on the directive function of autobiographical memory has begun incorporating motivational and behavior change theoretical frameworks that also are predictive of health behavior, in particular SDT (Milyavskaya, Philippe, & Koestner, 2013; Philippe et al., 2013). These studies suggest that directive memory research can benefit from incorporating behavior change concepts in its design.

Our prior research (Biondolillo & Pillemer, 2015) investigated a novel, memory-based intervention to promote the self-reported physical activity of college students. The intervention consisted of a short, one-time prompt administered amidst other questionnaires. It asked participants to think about and describe either a prior positive or negative motivational physical activity experience. The intervention, though discrete and minimally time-consuming, was effective at influencing the self-reported physical activity of a sample of college students who were not specifically seeking behavior change over the course of a 7-day period following the memory prompt. Specifically, individuals who were prompted to describe a positive motivational exercise experience reported greater exercise activity at follow-up than participants in a no-memory control condition. Those who described a negative motivational exercise experience reported an intermediate amount of exercise that was not statistically different from either the positive memory or the control groups.

The effect of the positive motivational memory intervention was evident even after controlling for participants' prior reported exercise activity, their prior exercise attitudes, and their prior motivation for exercise as measured with an SDT instrument. Furthermore, at follow-up participants reported in an open-ended question the strategies they used for motivating themselves to exercise and in no instance did a participant report using memory as a motivational tactic. As participants also did not experience a change in their attitudes, or motivation for exercise between Time 1 and Time 2, we reasoned that the effect of the memory intervention was largely implicit. This preliminary evidence is limited by its reliance on self-report measures of exercise.

Research on the directive function of autobiographical memory is sparse in adolescent samples. Pickrell et al. (2007) performed an autobiographical memory intervention designed to restructure the memories of children needing dental treatment. In their study, children ages 6-9 years attended two dental visits two weeks apart. At the first visit, children had their pictures taken while smiling prior to the treatment and were asked to rate how much pain and anxiety they experienced immediately following the treatment. Prior to receiving treatment at a second visit, all children were shown the photo of themselves from the first visit, but those in an intervention condition were told by the experimenter how happy they looked, were asked to verbalize how well they had behaved at the prior visit, and were praised for and asked to demonstrate specific positive behaviors they had performed at the first visit (such as lying still). When prompted to recall their first visit, children whose memories were experimentally manipulated prior to the second treatment recalled experiencing less fear than they had at the first visit and children who had participated in a neutral discussion control condition reported experiencing more fear and pain than they had at their first visit. Additionally, blind coders rated how well children had behaved at each visit, and those in the intervention group were more likely to improve from the first to second visit than those in the control condition. Although this study is not a perfect analogue to the aforementioned research on the directive function of autobiographical memory, it does demonstrate that interventions targeting autobiographical memory can be effective at influencing health-related behavior in younger populations.

What is unknown from the extant research on the directive function is whether memory-based cognitive strategies can be taught to adolescents for self-regulation of motivation and behavior. Although directive memory research describes case examples of children and adolescents using memories as directives (Pillemer, 2003), no experimental studies have directly examined the impact of recalling a specific episode on behaviors in adolescents. Developmental research on autobiographical memory supports the idea that young adolescents can benefit from the use of autobiographical memories to direct their behavior.

Autobiographical Memory Development

Autobiographical memory is important for the organization of a coherent life narrative and a sense of self (Habermas & Bluck, 2000; Fivush, Habermas, Waters, & Zaman, 2011; Fivush & Nelson, 2004) and the content of autobiographical memories is theorized to reflect goals important to the self (Conway & Pleydell-Pearce, 2000). Biology and the sociocultural environment contribute to the development of one's autobiographical memory abilities from birth through adolescence, and research on the development of brain areas supporting autobiographical memory and on the sociocultural processes that influence the expression of autobiographical memory suggest an autobiographical memory-based memory intervention may help adolescents regulate their motivation for physical activity.

Brain regions that underlie episodic memory, episodic future thinking, and autobiographical memory, such as the medial prefrontal cortex (mPFC), the posterior cingulate cortex (PCC) and the medial temporal lobes (MTL) belong to a network of brain regions known as the Default Mode Network (DMN; Buckner & Carroll, 2007). This network is theorized to support adolescent self-concept development and the ability to use autobiographical memories to reason about the life story, among many other cognitive abilities (Habermas & Bluck, 2000; Sebastian, Burnett, & Blakemore, 2008). The anatomical development of these brain regions correlates with the development of autobiographical memory abilities. For example, the volume of the MTL, which includes the hippocampus, a structure thought to contribute to the encoding and recollection of details of particular episodes in memory, achieves relative stability around age 4 (Lenroot & Giedd, 2006) and this region is linked to the onset of long-term episodic memories that persist from preschool age into adulthood (Fivush, 2011; Pillemer & White, 1989). Additionally, the structural and functional development of the mPFC and MTL regions of this network have been shown to achieve adult-like levels by age 9, suggesting that by this age children may be able to demonstrate relatively mature autobiographical memory abilities (Supekar et al., 2010).

Autobiographical memory development is also influenced by memory sharing between caregivers and their children, in which caregivers model the structure and uses of autobiographical memory (Fivush & Nelson, 2004). Research has shown that mothers differ in how they reminisce with their children and that their style of reminiscing may influence the development of autobiographical memory (Fivush & Nelson, 2004). For example, Fivush, Haden, and Reese (2006) found that mothers who were more elaborative with their children, or those who asked more open-ended questions and added more specific and emotional detail to their memory narratives, had children with better developed autobiographical memory abilities, including the use of self-generated memory strategies to plan for the future. As early as caregivers and children start engaging in joint reminiscing, caregivers model the use of autobiographical memories as directives by recalling and discussing past episodes that could provide important information to guide their children's future behavior (Kulkofsky & Koh, 2009).

The implication of this developmental trajectory is that even young children should be able recall past events, simulate future events, and perhaps be able to use memory to regulate their behavior. As discussed previously, the content of autobiographical memory has been shown to affect the immediate behavior of young children (Pickrell et al., 2007), and children can be taught to regulate their own use of imagery to achieve important goals (Munroe-Chandler et al., 2012); however, the imagery children were taught to use in this intervention only focused on imaging the motor performance of a skill and may not have implicated a sense of self, an important component of mature autobiographical memory (Fivush & Nelson, 2004). Likewise, the intervention used by Pickrell et al. (2007) required the use of specific probes to reframe and restructure children's memories and it is unknown if the children actively used the memory to modify behavior even in the short-term.

Autobiographical memory research indicates that when younger children do use memory to guide behavior they may rely more on their memory of scripts, semantic knowledge of what happens during particular events, than on projecting one's sense of self into the future (Fivush, 2011). One explanation for the results of the intervention used by Pickrell et al. (2007) to influence children's behavior in a dental clinic is that it may have influenced this semantic episodic knowledge of what is normative behavior at the dentist and not the children's idiosyncratic representations of themselves or of the prior event. Therefore, it is yet unknown how and if children can employ autobiographical memory as a self-management strategy to regulate their own behavior over a longer term to achieve important goals for a temporally distal desired self (Ghetti, Mirandola, Angelini, Cornoldi, & Ciaramelli. 2011; Sallis et al., 1997).

The development of those regions of the DMN that underlie representation of the self in autobiographical memory and the development of self-concept undergo a more protracted course of anatomical maturation than those regions implicated in the episodic representations of autobiographical memory, and this development continues into adolescence (Sebastian, et al., 2008). In a review of research on the development of the cognitive tools necessary to generate a life narrative, Habermas and Bluck (2000) found that individuals' life stories do not exhibit the type of global coherence shown in adults' life stories until about the age of 12. Others have also suggested that the coherent, relatively stable self-identity that organizes the important autobiographical memories that define the individual's life and reflect important life goals develops during adolescence (Fivush et al., 2011). With this identity, an adolescent may be able to use memories of past goal achievement or of failure to plan for future goal striving and to inform current behavior. This conclusion is supported by research examining self-esteem memories in adolescents and adults.

Ivcevic, Pillemer, and Brackett (2010) investigated the thematic content of adolescents' self-esteem memories – those that made them feel especially good or bad about themselves. The researchers found that the thematic content of adolescents' self-esteem memories was similar to that of self-esteem memories of young and older adults in prior studies (Pillemer, Ivcevic, Gooze, & Collins, 2007; Ivcevic et al., 2008). Specifically, positive self-esteem memories reflect achievement successes and negative self-esteem memories reflect interpersonal failures. The correspondence between the thematic content of self-reflective autobiographical memories of adolescents' and adults' autobiographical memories suggests that adolescents may have a mature sense of self represented in their autobiographical memories replete with representations of goals similar to those of adults. Ivcevic and colleagues (2010) suggest that just as adults, adolescents may use these self-referential, affect-laden memories as directives for future behavior.

In summary, autobiographical memory is linked to intentions and behaviors in multiple domains. Research on the directive function of autobiographical memory indicates adults can benefit from the use of personal memories to direct their behavior. Developmental research suggests that the same links between memory and behavior may exist for adolescents and that normative biological and sociocultural processes allow for mature autobiographical memory use in adolescence; however, the effect of autobiographical memory use on behavior in adolescence has yet to be directly examined.

Aims of the Study

The present study examined an autobiographical memory intervention as a means to motivate physical activity in secondary-school students. As adolescents entering middle school may be most at risk for experiencing decreases in their physical activity patterns that could persist into adulthood (Herman et al., 2009; Malina, 2001; Sacker & Cable, 2005) and are forging an identity that helps to define future goal striving (Fivush, 2011; Habermas & Bluck, 2000), such an intervention, if effective, could be an efficient tool to employ on its own or in conjunction with traditional interventions for the long-term maintenance of healthy physical activity patterns.

To further elucidate the mechanism of memory's effects, we utilized measures of intrinsic motivation (inspired by SDT) and self-efficacy (inspired by TPB, SCT, and TTM) to examine if the effect of the autobiographical memory intervention might interact with some common determinants of physical activity. Additionally, we employed an objective measure of physical activity in addition to a self-report to investigate if the impact of memory on physical activity could be detected in an objective measure of physical activity.

We hypothesized that the memory intervention would have a positive effect on physical activity as measured by self-reported exercise activity, intentions to attend an optional afterschool physical activity session, attendance at the optional physical activity, running times in physical education class training sessions for an all-school, end-of-year race (the Bagel Challenge), and the time run during the Bagel Challenge. Exploratory analyses examined the effects of students' grade, sex, and pre-intervention levels of self-efficacy and intrinsic motivation on outcomes. If the ability to use directive memories as a self-regulatory strategy does necessitate the activation of an imagined future self, one would expect older adolescents would be most capable of benefitting from the intervention, as the ability to think about the self matures over the course of adolescence (Habermas & Bluck, 2000; Sebastian et al., 2008); however, research on the directive impact of memories has yet to examine if children's and adolescents' abilities to think about the self predicts their abilities to use memories as directives. Furthermore, the intervention is minimal and may not provoke an individual to project him or herself into the future. Sex of participant is a potential moderator as gender differences in physical activity (Sallis et al., 2000) and in memory (Herlitz & Rehnman, 2008) are well documented even in childhood, with females showing an episodic memory advantage. Additionally, intrinsic motivation and self-efficacy may moderate the effectiveness of the intervention as both of these qualities have been shown to be predictive of adolescent physical activity (Plotnikoff et al., 2013), and self-efficacy has been shown to relate to children's use of self-regulatory strategies to motivate physical activity (Dishman et al., 2005).

METHOD

Participants and Procedures

Parents/legal guardians of students at a New England middle school were emailed a passive consent form by the principal of the middle school one week prior to the start of data collection; the passive consent form was emailed a second time three days prior to the start of data collection (see Appendix C for study documents and measures). These forms provided parents/legal guardians with a summary of the study's aims, a list of potential risks of engaging in the research, an overview of how the data would be used, a description of the researchers' confidentiality practices, a statement that students could win an Amazon gift card for participating, and contact information for the principal investigator and for the director of the institutional Research Integrity Services. Parents wishing to exclude their child/children from consideration for the study were asked to sign the form and have their child return it to their physical education teacher who would then give it to the principal investigator.

All data collection was intended to take place during students' physical education classes (with the exception of measures taken during race day and attendance at an optional afterschool physical activity session). Physical education classes met two or three times a week, either on Mondays and Wednesdays or Tuesdays and Thursdays with occasional Friday classes for those meeting Monday and Wednesday. Due to unforeseen scheduling conflicts, additional data collection occurred outside of physical education classes but still during the school day for follow-up (Week Six) assessments as most students did not have physical education classes that week (see Appendix E for schedule of assessments).

Physical education classes were composed of two sections of students from the same grade who were supervised by one of three physical education teachers. Each section was composed of approximately 20 students, and therefore each class was composed of approximately 40 students and two teachers. This amounted to 16 different classrooms of students, four per grade, and three different teacher pairings. One teacher had missed time earlier in the school year due to injury, and taught part-time during the study period with a substitute replacing her for afternoon classes (fifth and eighth-grade classes), but all teachers met with their classes consistently without absence for the study period. Each day, two classes from each grade met for physical education (eight classes per day).

Data collection began during the students' first physical education class during the second week in May (Week One of the study). At this initial session the principal investigator introduced himself to students and informed them of the study aims and procedures and informed them that students participating in the study would be entered into a raffle for 10 Amazon gift cards to be disbursed after the Bagel Challenge. Students whose parents did not withdraw them from the study were provided a packet consisting of all Week One assessments. The first form in the Week One packet was the assent form. Students were asked to review the form and to ask questions about the study procedures before signing their assent. To help ensure confidentiality, all written assessments given to students each week were covered by a blank page so that responses to all questions could be kept private, and students were asked to sit along the outside of the gymnasium while completing all written assessments. If a student was withdrawn by a parent or guardian or did not want to participate, they were given an alternative assignment to complete by their physical education teacher that concerned setting goals for training that could be completed each week and took approximately the same amount of time to complete as study assessments.

After providing written assent, students completed a survey consisting of questions concerning background demographic information (name, gender, date of birth, grade, race/ethnicity, and an open ended list of afterschool activities), their intrinsic motivation for physical activity, and self-efficacy for physical activity in that order.

The total sample consisted of 558 adolescents. Of these participants, 10 had given their assent after having completing later weeks due to absence on the assent day and were excluded from all analyses. The final Week One sample consisted of 548 participants (290 female; 252 male; 6 missing or other). The mean age was 12.65 years (*SD* = 1.18). The participants were fairly evenly split between the four grades at the middle school (137 in fifth; 137 in sixth; 147 in seventh; 127 in eighth). The majority of participants reported their race/ethnicity as white/Caucasian (84%) and many reported being unsure or omitted the question (14%).

During students' second physical education class of Week One, they participated in a training run for the Bagel Challenge and their times were recorded. One sixth-grade and one seventh-grade class did not meet as regularly planned during their first physical education class of Week One. As a result, assent and background measures were attained during the second physical education class of that week for these classes, prior to their running of the training run. In addition, one fifth-grade class did not meet at all during Week One and was allowed to complete Week One and Two assessments during Week Two.

During the first physical education class of the following week (Week Two), students were asked to complete the PAQ-C question as a baseline self-report measure of general physical activity. In their second class of Week Two, students were again timed in their training run.

During this week of the study, the principal investigator was informed that some students in seventh and eighth grade were on a field trip for the school band during parts of Weeks One and Two. For this reason, recruitment of participants continued into Week Two and students who had missed any Week One or Two measures were encouraged to complete them before the end of that study week. Many students in the band indicated either verbally or in writing on the PAQ-C question that their week during the band trip had been abnormal in terms of physical activity; therefore, we obtained a band roster to allow analyses of self-report data with and without band members in the sample.

The memory intervention occurred during Week Three. For randomization, two physical education classes per grade level were randomly assigned to receive the experimental treatment and the other two classes in each grade level were randomly assigned to receive the control treatment. This cluster assignment procedure was used because random assignment of students within classes would not have been practical in the everyday school setting. Cluster randomization also ensured that all four grades had an equal number of experimental and control classes and made it less likely that students would find out from their friends that there were different conditions.

Although cluster randomization may introduce bias through the use of existing groupings that can arbitrarily differ from one another, the school district in which we performed the research makes a concerted effort to create heterogeneity in classrooms. The strategic plan for the school district lists "Inclusion and Heterogeneous Groupings" among their primary goals (Oyster River Cooperative School District, n.d.). They write:

> We value the right of our children to participate fully in the classroom with respect for all students' social, civil and educational opportunities and rights. Our classroom approach is

> based on combining students of all learning styles and varying skills and abilities into single classroom settings in which all students learn together in cooperative learning arrangements.

This commitment to create heterogeneous classrooms ought to minimize any bias resulting from cluster randomization.

Administration of the experimental procedure occurred at the start of the first physical education class of the week for all groups; however, due to a holiday and field trip, the school was closed on Monday and Friday of the intervention week and thus students on a Monday/Wednesday schedule completed the intervention on Wednesday instead of Monday. In addition, three out of four of the fifth-grade classes (one experimental class and two control classes) were not scheduled to have physical education classes as they prepared for a bicycle safety day during that part of their school day. The experimental manipulation for those classes was re-scheduled to the following week.

Students in the experimental group were given the following prompt for a positive motivational memory of physical activity:

> Sometimes people feel like they want to be physically active and other times they don't. In order to get motivated to be physically active, some people find it useful to think about a **positive past experience**.
>
> In the space below, please write about a specific experience from any time in your life when you did something physically active and felt especially **good about yourself**. This experience should be a **MOTIVATIONAL MEMORY**, a memory you would think about when you feel you want to be physically active.
>
> Your memory should be about a **positive experience** that happened at a particular

time and place. I'd like to know where you were, what you did, how you felt, and any other details about your positive physical activity experience.

This prompt was adapted from Biondolillo and Pillemer (2015) in order to be understandable to the middle school students. The prompt was written and revised by the principal investigator with input from the school's physical education teachers and was approved by the physical education teachers and principal. On the page following the prompt and writing space for the memory was the following sentence, "You can think about this memory to get motivated to be physically active any time you want!" Immediately following this suggestion, students were asked to rate the positive affect associated with the experience described in the memory using a 5-point scale.

In the control condition, students were asked to write about their favorite subject to study in school. They then rated their affect in regards to the school subject described on a 5-point scale identical to that used by participants in the experimental condition. The control condition prompt was as follows:

> Sometimes people like to think about their favorite subject to study in school and other times they don't. In order to do well in school, some people find it useful to think about their favorite subject to study in school.
>
> In the space below, please write about your favorite subject to study in school.

No suggestion was given that the control memory could be motivational. The control prompt was intended to cue positive, general, semantic memories in a domain unrelated to physical activity for comparison to the specific episodic memories in a physical activity domain we had intended to cue with the experimental prompt. Effort was made to keep the principal investigator blind to which groups were assigned to which condition; however, students made it apparent to the principal investigator with their questions about the prompts which classes were in which condition. Still, physical education teachers were kept at a distance during administration of the intervention to prevent them from reading the prompts or the memories written by students, and all students were asked to come to the principal investigator with any questions or issues during administration of the experimental prompts in order to keep teachers blind to assignment. Teachers maintained they were unaware of which students were given which prompt throughout the study.

Following the intervention, all students responded to a question regarding their intentions to attend an optional physical activity session occurring after school that may help them train for the Bagel Challenge and that was to be offered to them the week after administration of the intervention. This question served as an immediate measure of student intentions to partake in optional physical activity. Due to teachers' schedules afterschool and in order to allow for all students to be able to attend the optional session (including the three fifth-grade classrooms that had to complete the intervention the following week), the optional physical education session had to be pushed back a week from its intended date. This put it at two weeks after answering the intention question for 13 out of the 16 classes instead of one week after as indicated in the question itself. To ensure all participants could interpret the question in the same way at the time of responding to the question, a date was not given for the optional physical activity session at the time of the intervention for any class and a firm date was announced only after all classes had undergone the experimental treatment.

After completing the experimental procedure, participants in both groups completed another timed training run. The times run in training immediately following the intervention served as a measure of the effect of the intervention on objectively measured physical activity closely following memory intervention. The Bagel Challenge course winds throughout the neighborhood surrounding the middle school; however, the week of the experimental manipulation temperatures were in the mid-90s°F, and heat advisories were in effect throughout the school day each day. In order to ensure student safety, the decision was made to run an alternative training course on the athletic fields of the middle school that was measured to be the same distance as the normal training course and that would allow for easier monitoring of students. It should be noted, however, that the normal course contained several small hills whereas the alternative course was flat. Thus the alternative course was a close approximation but not an analogue to the normal course.

The three fifth-grade classes who completed the intervention during Week Four of the study did not have to contend with the heat; however, their teachers wanted to allow them to run the normal course because canceled classes and field trips had kept them from running the course as often as other students, and the teachers wanted to familiarize the fifth-grade students with the course to ensure their safety on race day.

During the first physical education class of Week Four, students who had completed the intervention the week prior were asked to fill out a follow-up PAQ-C question to allow for analysis of change in self-reported physical activity following experimental manipulation. As this measure captures a one-week timeframe, we wanted to allow at least one week between experimental manipulation and the second PAQ-C measure, so classes completed the measure on either Tuesday or Wednesday of the study week, depending on when their intervention had occurred in Week Three. A question added at the end of the PAQ-C administered during this study week asked students to indicate (*Yes* or *No*) if they had used the memory recalled during physical education classes the week prior any time since then in order to motivate themselves.

This question was intentionally worded to be general in order to avoid priming the control group to use memories as motivation for physical activity and so that the same wording could be used for both groups. Therefore the only treatment that differed between groups was the experimental prompt. The prompt was intended to measure the power of the suggestion to use the memory for the intervention group and as a cue for the intervention group to recall and rehearse the memory in order to use it as motivation.

Students' times running the training course were again recorded this week (Week Four), but due to heavy rains on Monday and Tuesday of that week, no runs could occur those days. Additionally, the intervention could not be made up on those days for the three fifth-grade classes that did not attend physical education the week prior, so the intervention was delayed to Wednesday and Thursday of that week for those classes. In addition, one sixth-grade class and one eighth-grade class did not meet on Wednesday of Week Four, and the collection of their second PAQ-C had to be delayed until Week Five.

After the last class had completed their intervention, the principal investigator and physical education teachers scheduled the optional physical activity session to occur the Thursday of Week Five. This would allow for all classes to be reminded of the session during each of their two physical education classes of that week, and the afterschool session would not coincide with the seven-day period that would be captured in the second PAQ-C for any class.

Week Five of the study allowed for the collection of data that had been pushed back due to weather or other issues that necessitated the rescheduling of prior assessments. During this week, all prior classes that had not already filled out the second PAQ-C question and question regarding their use of memory as motivation were able to complete them. At the beginning of all physical education classes that week, the physical education teachers informed students about the optional physical activity session for Bagel Challenge training to be held in the school gymnasium after school Thursday and reminded them that attendance was encouraged, but voluntary.

The morning of the optional physical activity session, the principal investigator hung 8"x11" flyers near every exit from the school reminding students about the physical activity session to occur after school that day (see Appendix D). An announcement was also made over the P.A. system during morning and afternoon announcements as a reminder about the optional session. At the end of the school day, the principal investigator waited outside of the gymnasium with a sign-in sheet for students participating in the optional session to sign upon entry. One physical education teacher agreed to stay after school to supervise the session and to give access to sports and fitness equipment. The physical activity session lasted approximately 30 minutes, after which time the teacher led students to a local bistro and generously treated them to a bagel, the food that is the namesake of the Bagel Challenge. Students attending the after school physical activity session were either picked up by a parent or guardian, or were able to take a later bus home.

The final week of data collection included measures of the time run by students at the Bagel Challenge race on Monday of that week. At the event, students, faculty, and staff gathered near the finish line to watch the students run the 1.1-mile course. In addition to running, the jazz band performed throughout the day. The event itself started at 8:30 am and lasted until 12:00pm.

The students were grouped primarily by their fastest training time into nine heats of runners. Exceptions to that grouping included one heat composed of jazz band performers that ran the first heat when most students were not yet observing at the finish line, and a "costume heat" composed of eighth-grade students who ran or walked in all kinds of costumes. There was one heat for the fastest runners (those who ran under nine minutes in training) and the remaining six heats were split by gender into two heats of students who ran between nine and 12 minutes, two heats of students who ran between 12 and 16 minutes, and two heats of students who ran in greater than 16 minutes during their fastest training run. Each heat consisted of approximately 75 students. At the start line, one of the physical education teachers signaled the beginning of each heat and would communicate with another physical education teacher at the finish line that a new heat was starting, thus allowing for the timing clock at the finish line to be reset. The finish line of the course was a large inflated bagel through which students could run and next to which was a digital time clock with a 4" LED display that was provided by the principal investigator. The clock was set up on a tripod so students could see their times as they finished. Beyond the finish line were three tables, each with the name of one of the physical education teachers displayed on 8"x11" signs taped onto them. The rosters of each of the teachers were either taped to the tables or on clipboards at the table for that particular teacher. Volunteers were stationed at each table, at the finish line, and approximately 100 yards before the finish line to remind students to look at the clock for their time, and to help them record their time on the correct roster. A few small 8"x11" signs were posted around the finish line with the phrase, "Please remember to look at the clock for your time," printed on them.

As the Bagel Challenge began, it became clear that students were not finishing fast enough to allow for researchers to reset the clock for the beginning of the upcoming heat as the runners at the end of a prior heat would not get their correct time from the clock. To keep from attaining systematically deflated run times recorded for the students at the end of heats, the decision was made to keep the clock running for the heats when students were running slower and for a researcher to keep time for the next heat on his own watch and yell out the finishing time for each student. Unfortunately, this improvised timing system resulted in some confusion at the finish line as some students began finishing before the students from the prior heat had finished, and the volunteers kept their own time via stopwatch and yelled out runners' times as they finished until there was no longer any overlap of heats running the course. The researchers present at the Bagel Challenge determined that those times above 15 minutes (the minimum times between the start of each heat) may not be highly reliable. Still, as measurement error was not specific to any particular group or grade, the researchers decided to include all times in analyses of Bagel Challenge run times. Students' times run during the Bagel Challenge itself served as a final objective measure of the effect of the intervention.

The Bagel Challenge course itself is actually slightly longer than the training course used during physical education classes, so students' times run on race day were used as an outcome variable in lieu of a measure reflecting a change in running time from the intervention day training run.

In the three days following the Bagel Challenge, the final questionnaires were administered to students. These asked for a final self-report of physical activity as well as for students to rate their enjoyment of the Bagel Challenge on a 5-point scale identical to that used to rate memory affect. Students also were asked to indicate (*Yes* or *No*) if they had achieved their goals during the Bagel Challenge and if they had used the memory they recalled for the intervention at any point during the Bagel Challenge to motivate themselves. On those days, in lieu of having physical education students had field day activities on the athletic fields of the school. With permission from the principal and students' own teachers, the principal investigator approached several teachers during field day to have their students complete the final questionnaires. After reviewing which classes had completed assessments during field day activities, it was found that not all grades and conditions had been sampled. The principal investigator then went to classrooms representing the grades and conditions that were not represented in data collected during field day in order to obtain responses from at least one section within each condition and grade on the final assessment.

After collecting all data, two students from each grade and two additional students from any grade were randomly selected as winners of the raffle for Amazon gift cards. Their gift cards were left with the principal in order to be disbursed directly to students. Following completion of all aspects of the study, a debriefing form was emailed to parents of students at the middle school by the middle school principal.

Of the 548 participants completing Week One assessments, 123 were omitted from analyses for various procedural issues or absences on critical data collection days. Eighty-nine students were omitted for failing to give a memory, for giving a memory following intervention day, for reporting a clearly negative memory (self-rated as lowest score, 1, on positive affect of memory scale), or for reporting a memory about physical education, recess, or lunch for students in the control condition. Participants recalling physical education or recess as their memory were omitted because the memory prompt was worded to discourage reports that could prompt a student to think about his/her physical self-concept or about physical activity behavior. Those who reported about lunch were omitted as this was not a school subject. One participant filled out two memory reports and was omitted. Two participants were excluded due to disclosing injuries that did not otherwise keep them from attending physical education classes but that did affect their physical activity in or outside of physical education classes.

Finally, 30 participants were excluded due to issues encountered in data collection. Training logs filled out by these students' physical education teachers either conflicted in their reports of dates when training runs occurred or did not have an adequate number of dates recorded to determine when runs had occurred. The final sample consisted of 425 students (234 female; 185 male; 6 missing or other) with a mean age of 12.59 years (*SD* = 1.17). All reported analyses include only these 425 participants unless otherwise specified.

Measures

Intrinsic Motivation Inventory (IMI; Ryan, 1982). The IMI is a multidimensional instrument that is designed to assess a participants' subjective experience regarding an activity. The original instrument contains 45 items composing seven subscales. Each item asks respondents to indicate on a seven-point Likert-type scale how true a statement is for the respondent in regards to a particular activity (*not at all true = 1; somewhat true = 4; very true = 7*). The directions and items can be adapted to suit the needs of the researcher. For the purposes of this study, items were selected from three subscales (interest/enjoyment, perceived competence, and perceived choice) intended to be positively predictive of physical activity and to capture participants' degree of autonomous self-regulation for physical activity as described in SDT (Ryan & Deci, 2000). Four items were selected from the interest/enjoyment subscale, three from the perceived competence subscale, and three were selected from the perceived choice subscale. The interest/enjoyment items were: 'I enjoy physical activity very much', 'I think physical activity is a boring activity' (reverse scored), 'I think physical activity is quite enjoyable', and 'Physical activity is fun to do'. The perceived competence items were: 'I think I am pretty good at physical activity', 'I am pretty skilled at physical activity', and 'I cannot do physical activity very well' (reverse scored). The perceived choice items were: 'I believe I have some choice about physical activity', 'I do physical activity because I have to' (reverse scored), 'I do physical activity because I want to.'

The measure's authors suggest performing factor analyses on IMI items and only including items whose factor loadings for its subscale exceed 0.6 (Ryan, 1982). Factor analyses were performed on all three subscales created for this study using primary axis factoring. One item failed to achieve a factor loading of 0.6 on the perceived choice subscale. The item, 'I do physical activity because I have to' was omitted and the measure of intrinsic motivation used in analyses was recomputed without this item. The Cronbach's alpha coefficient for the nine-item scale within the sample of non-omitted data was .93. A factor analysis using primary axis factoring was run on the nine-item scale to confirm the presence of one factor representing students' intrinsic motivation. One factor achieved an eigenvalue greater than 1 and this factor accounted for 65.88% of the variance in the data.

Self-Efficacy Questionnaire (Motl et al., 2000). A scale to assess adolescents' self-efficacy to be physically active was taken from Motl et al.'s (2000) study of determinants of physical activity in eighth-grade girls. In their study, eight items composing a single factor were selected to form a self-efficacy scale for physical activity in adolescent girls and this scale was cross-validated in a second cohort of adolescent girls. On this measure, students are asked to rate the degree to which they agree or disagree with the eight statements on a five-point Likert-type scale (*disagree a lot = 1; agree a lot = 5*). Examples of items on the self-efficacy scale include 'I can be physically active during my free time on most days', 'I can ask my parent or other adult to do physically active things with me', and 'I have the coordination I need to be physically active during my free time on most days.' A single score of participant self-efficacy for physical activity was computed by taking the average of all items answered by each participant who had responded to at least six of the eight questions. The Cronbach's alpha coefficient for the full eight-item scale was .87.

Physical Activity Questionnaire for Older Children (PAQ-C; Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997). The PAQ-C is a seven-day physical activity self-report instrument validated for use with children between the ages of 8-14 years old during the school year. This measure was selected over others as it could capture changes occurring between scheduled measurement occasions, and it has been found to be a valid and reliable self-administered assessment of physical activity in young adolescents in comparison to other seven-day self-report measures (Cancela, Ayan, & Castro, 2013). For the purposes of this study, one item from the original scale was selected to act as an index of physical activity outside of the classroom. The item asked students to select the one statement out of five that best described their physical activity over the last seven days. The options were scored on a one to five scale in order of increasing physical activity frequency. Choices were, 'All or most of my free time was spent doing things that involved little physical effort', 'I sometimes (1-2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics)', 'I often (3-4 times last week did physical things in my free time', 'I quite often (5-6 times last week I did physical things in my free time', and 'I very often (7 or more times last week) did physical things in my free time.' Participants completed this question at Weeks Two, Four, and Six (follow-up). At Week Four, a follow-up question asked if the student had thought about the memory given the week before in order to try and motivate themselves (*Yes = 1; No = 2*).

Training Times. Students' times running the Bagel Challenge course for training were tracked by the students' physical education teachers on spreadsheets with a row for each student and several columns for the days. Training times were recorded on these spreadsheets either by the physical education teachers themselves or by another student selected by the physical education teacher to time the other students and record their times that day. Often this was a student who was injured or excused and not able to run.

Memory Affect. A question was asked following participants' memory reports regarding the positive affect associated with the memory. This question was accompanied by both text responses and corresponding illustrated faces demonstrating the positive affect of each response choice. This was done as research has shown that children and young adolescents may have difficulty understanding and responding to scales assessing subjective judgments (Chambers & Johnston, 2002). The question asked participants to circle the word or face that describes how good they felt during the experience they wrote about in their memories. Response choices were displayed on a five-point Likert-type scale with the illustrated faces displayed above the text (*Not at all = 1; A little = 2; Somewhat = 3; Quite a bit = 4; A lot = 5*).

Intentions to Attend Optional Physical Activity Session. Following memory reports and affect ratings, a prompt informed students of an optional short (30 minute) physical activity session that could help them prepare for the Bagel Challenge to occur the following week in the gym after school. Participants were asked to indicate if they would be interested in attending the session (*Yes I'm interested and I plan on going = 1; Yes I'm interested but I won't be able to go = 2; No I'm not interested in going = 3*).

Follow-Up Questionnaire. The week of the Bagel Challenge and following the race itself, participants were asked to report about their experience having run the Bagel Challenge. Using the same five-point scale and answer choices as the positive affect of memory question, participants were asked to indicate how much they enjoyed running the Bagel Challenge. A second question asked, 'Did you achieve your goals during the Bagel Challenge?' (*Yes = 1; No =2*). A final question reminded participants about having written about a memory as part of the study and asked if they had thought about the memory at any time during the Bagel Challenge to try and motivate themselves (*Yes = 1; No = 2*).

RESULTS

As a consequence of the variability in intervention day weather conditions and school schedule, the data from fifth-grade students were split into a separate file for analyses. One data analysis strategy that was considered was the analysis of change over time in students' training times through multilevel modeling; however, since the intervention day training run was on a different course than the one used for prior and subsequent training runs, we decided the conservative approach would be to examine intervention effects on training times solely on the day of the intervention when conditions were most similar for sixth through eighth-grade classrooms. Analyses of change over time were run for exploratory purposes, as the course used for intervention day was equivalent in distance to the Bagel Challenge training course, and these supplementary analyses can be found in Appendix B. Analyses of data from fifth-grade students will be presented in a separate section.

Analyses were run in the following sequence. First, background variables were examined for normality and to examine if IMI and self-efficacy predicted self-reported physical activity. Background variable means were also compared for equivalency between the experimental and control groups, between male and female students, and between grades. Second, intervention day self-reports of intentions to partake in optional physical activity were examined through chi-square tests of independence to see if self-reports of intentions differed by experimental condition, sex, or by grade. Third, students' self-reports of physical activity were compared between the intervention and control groups using analysis of covariance controlling for self-efficacy and intrinsic motivation. Fourth, intervention effects were examined using analysis of covariance controlling for self-efficacy and intrinsic motivation on intervention day training times. Fifth, a multilevel modeling (MLM) analysis was performed to examine if intervention day training time effects varied as a result of our randomization procedure. Sixth, times run on the day of the Bagel Challenge were examined through factorial analysis of variance with grade and condition as fixed factors. Lastly, post-race questionnaire measures of self-reported physical activity, memory use during the Bagel Challenge, and enjoyment of the Bagel Challenge were compared between experimental and control groups.

Preliminary Analyses

To screen for any violations of assumptions of normality, measures of skewness and kurtosis and histograms of all quantitative predictor and outcome variables were requested in SPSS and examined for unusual distributions and for outliers. To screen for bivariate normality and for homogeneity of variance, bivariate scatterplots were requested in SPSS between pairs of continuous predictors and between continuous predictors and outcome variables and examined for bivariate outliers. In addition, we regressed training time on self-efficacy, intrinsic motivation, student sex, experimental condition, dummy codes for grades 6, 7, and 8, and the time variable created to represent day of training using ordinary least squares regression. A normal P-P plot was requested, as were partial regression plots of the residual error term for training time on each predictor variable to test for normality of error terms.

Measures of skewness and visual inspection of histograms suggested that measures of intrinsic motivation and self-efficacy were slightly negatively skewed; however no serious violations of normality were noted in other variables. The bivariate scatter plots and the partial regression plots suggested that the variance of training time scores was more restricted at the extreme low end of intrinsic motivation and self-efficacy scores; however, the normal P-P plot indicated a relatively normal distribution of error terms in the model including all predictors.

Although violations of regression analysis assumptions appeared to be minimal, the data were examined with and without data from students with extreme low scores on intrinsic motivation and self-efficacy ($z < -3$). This led to the exclusion of data from four participants. After again examining partial regression plots an additional two cases were excluded due to self-efficacy measures that nearly met the $z < -3$ threshold still contributing to restricted variance of error in the training time measure. Analyses using either intrinsic motivation or self-efficacy were run without these cases of extreme low values of self-efficacy and intrinsic motivation[1].

To ensure that background variables of intrinsic motivation and self-efficacy were sensitive to and predictive of differences in physical activity, the measures of intrinsic motivation and self-efficacy for physical activity were correlated with students' pre-intervention self-reports of physical activity in the dataset containing all grades of students. Students' IMI scores were significantly correlated with their self-reported physical activity, $r(389) = .47$, $p < .001$, as were their self-efficacy scores, $r(385) = .43$, $p < .001$.

Next, students' memories were examined to see if the memory prompt was successful at cueing positive memories. As an example of a typical positive motivational memory, one female student in sixth grade wrote, "Last year when I played basketball I played a middle school team in Deerfield, we lost by 2 points but I did a very good job and I played my best that was my best game." Another female student in eighth grade wrote:

> When I was at the UNH track I decided to enter myself in hurdles. My stomach jittered with nerves. I didn't really know how to do hurdles so I practiced and fell

1. Two additional cases of extreme low intrinsic motivation and self-efficacy scores appear in fifth-grade students and those too were excluded from analyses of fifth-grade students in MLM.

twice! All my competitors were lining up. I heard "3…2…1…" and then the gun. I was off. I sprinted and jumped over the first hurdle. I heard a "uh-oh" and then a crash next to me. One competitor was down. I crossed the finish line with happiness, joy and pride. I made it, I finished the hurdles. Thank you for your time.

As an example of a typical control group memory, one female student in seventh grade wrote, "Science, because it is a really interesting class and I enjoy learning more about the world." Students' ratings indicated that each of the memory prompts was effective at cueing a positive memory. Students in the experimental condition judged their memories to be slightly more positive (*M* = 4.17, *SD* = .54) than did control condition students (*M* = 3.90, *SD* = .65, *t*(419) = 4.66, $p < .001$, *d* = .45, 95% CI [.16, .38]).

Using the data from sixth, seventh, and eighth-grade participants (*N* = 304), *t*-tests were run on the IMI, self-efficacy, and pre-intervention self-reported physical activity with experimental condition as the between-student factor. Significant a-priori differences were found for self-efficacy (experimental group *M* = 3.92, *SD* = .74; control group *M* = 3.72, *SD* = .80), *t*(300) = 2.29, *p* =.02, *d* = .26, 95% CI = [.03, .38]; differences in IMI scores approached significance (experimental group *M* = 5.73, *SD* = 1.01; control group *M* = 5.49, *SD* = 1.19), *t*(302) = 1.87, *p* = .07, *d* = .22, 95% CI = [-.01, .49]. Importantly, there were no difference in self-reported physical activity prior to intervention (experimental group *M* = 3.67, *SD* = 1.28; control group *M* = 3.49, *SD* = 1.25); *t*(275) = 1.17, *p* = .24, *d* = .14, 95% CI = [-.12, .48].

To examine gender differences on background variables, *t*-tests with gender as the independent variable were run on the IMI, on self-efficacy, and on pre-intervention self-reported physical activity. There were significant gender differences in IMI scores (male *M* = 5.83, *SD* = 1.04; female *M* = 5.46, *SD* = 1.13; *t*(297) = 2.89, *p* = .004, *d* = .34, 95% CI = [.12, .61]), and self-efficacy (male $M = 3.96$, $SD = 0.74$; female $M = 3.72$, $SD = 0.79$; $t(296) = 2.67$, $p = .008$, $d = .31$, 95% CI = [.06, .41]). There were no gender differences in pre-intervention self-reported physical activity (male $M = 3.74$, $SD = 1.32$; female $M = 3.48$, $SD = 1.20$; $t(270) = 1.69$, $p = .093$, $d = .21$, 95% CI = [-.04, .56]).

Next, one-way analyses of variance were run on the IMI, on self-efficacy, and on pre-intervention self-reported physical activity with grade as the factor. Grades did not differ significantly on any of these background variables (see Table 1). For intrinsic motivation, $F(2, 301) = .032$, $p = .97$, $\eta^2 < .001$; for self-efficacy, $F(2, 299) = .36$, $p = .70$, $\eta^2 = .002$; for pre-intervention self-reported physical activity, $F(2, 274) = 2.51$, $p = .08$, $\eta^2 = .02$.

Table 1.

Means and Standard Deviations of Background Variables in Grades 6 through 8.

	Grade 6		Grade7		Grade8		Total	
	M	SD	M	SD	M	SD	M	SD
IMI	5.60	1.11	5.63	1.14	5.63	1.07	5.62	1.10
Self-Efficacy	3.78	0.74	3.86	0.71	3.84	0.88	3.82	0.77
Self-Reported Physical Activity	3.70	1.18	3.64	1.27	3.28	1.40	3.56	1.28

Note: Total $N = 275$ cases listwise.

Intervention Effects

We examined the effect of the motivational memory intervention on our main outcome variables: intentions to partake in optional physical activity, self-reported physical activity, intervention day training times, and Bagel Challenge race time. As only three students attended the optional physical activity session (two from experimental group and one from control group), we could not compare groups on their attendance at this session. In addition to testing the effect of the experimental intervention, planned exploratory analyses were also run to examine gender and grade differences in intervention effectiveness and to investigate possible moderation of the intervention through intrinsic motivation and self-efficacy.

First, we dichotomized the responses to the intention question into two responses to indicate interest in attending. For this, the "Yes, I'm interested and I plan on going" responses were combined with the "Yes, I'm interested but I won't be able to go" responses. This was performed because scheduling issues with the optional afterschool activity made it such that students would not have been able to definitively answer if their schedules could accommodate the afterschool physical activity session. We then examined the relation between experimental condition and intentions to partake in an optional afterschool physical activity session. The relation between these variables was significant, $X^2(1, N = 308) = 7.61$, $p = .006$. Students in the experimental condition were more likely than those in the control condition to respond that they would attend or that they were interested in attending but could not (44.2% for experimental group, 29.0% for control group) than that they were not interested in attending the session (55.8% for the experimental group, 71.0% for the control group).

We then examined if the effect of the intervention on intentions differed according to sex or grade. For males, the condition-by-intentions chi-square test was in the predicted direction but not statistically significant, $X^2(1, N = 136) = 2.36$, $p = .105$; however, the condition-by-intentions chi-square test was significant for females, $X^2(1, N = 167) = 4.84$, $p = .028$. Whereas both males and females in the experimental condition were similarly likely to respond that they were at least interested in the afterschool session (for males, 44.2%; for females, 44.0%), fewer females in the control condition reported interest in the afterschool session (27.0%) than did control group males (30.5%), and this difference coupled with the smaller number of males in the sample contributed to the insignificant chi-square test in males.

Analyses examining grade level differences showed that the effect of the intervention on intentions depended on the student's grade. In all grades, the proportion of students in the experimental condition reporting their interest in the afterschool session (for sixth grade, 43.1%; for seventh grade, 52.9%; for eighth grade, 37.0%) was higher than the proportion of control group students reporting interest (for sixth grade, 34.6%; for seventh grade, 34.5%; for eighth grade, 13.2%), but the chi-square test approached significance for seventh-grade students and only reached significance for eighth-grade students. For sixth grade, $X^2(1, N = 110) = 0.83$, $p = .362$, for seventh grade, $X^2(1, N = 106) = 3.65$, $p = .056$, and for eighth grade, $X^2(1, N = 92) = 6.43$, $p = .011$. The proportion of control group students reporting their interest in the afterschool session was much closer to the proportion of students in the experimental group reporting their interest in sixth-grade classrooms (8.5% difference), than in seventh (18.4% difference) or eighth-grade (23.8% difference) classrooms.

The hypothesis that the memory intervention would lead to greater intentions to partake in voluntary physical activity for students in the experimental condition was supported. The memory intervention influenced students' who recalled a positive motivational physical activity memory to report greater intentions to partake in voluntary physical activity during their free time than students who recalled a control memory. This effect was somewhat more pronounced in female students and in seventh and eighth-grade students.

The effect of the intervention on students' self-reported physical activity in the week following the memory intervention was examined. The intervention group reported slightly more physical activity ($M = 3.40$, $SD = 1.27$) than the control group ($M = 3.31$, $SD = 1.27$); however, the difference was not significant, $t(286) = .58$, $p = .56$, $d = .07$, 95% CI [-.21, .38]. As the band had been on a field trip, during which time many students reported departures from their normal physical activity, we ran the analysis again excluding band members. Results were similar and the intervention effect did not change appreciably when students in band were excluded.

A series of exploratory analyses of covariance were performed examining the effect of the intervention on self-reported physical activity controlling for pre-intervention self-reported physical activity, self-efficacy, and intrinsic motivation. In addition, a 2x2 and a 2x3 factorial analysis of covariance were performed to examine the effect of the intervention on self-reported physical activity with the same control variables and the addition of either sex or grade as a factor. These exploratory analyses also failed to show an intervention effect either as a main effect or in interaction with grade or sex.

Lastly, planned moderation analyses were performed to examine if the effect of the intervention might be detectable in interaction with self-efficacy or intrinsic motivation. Although there had not been a detectible intervention effect on self-reported physical activity, an effect may be suppressed by a strong interaction effect. For these analyses, self-efficacy and IMI scores were mean-centered and the interaction terms of self-efficacy and IMI with experimental condition were added as covariates. The interaction terms of condition with IMI and with self-efficacy failed to reach significance, thus providing no evidence of moderation through either of these two background variables. Therefore, this analysis did not support our prediction that the memory intervention would influence self-reported physical activity.

The effect of the intervention on students' objectively measured training times recorded on the day of the intervention was assessed. In examining intervention day running times, there were some instances where teachers had recorded "20+" minutes run. This occurred for five control group students and 11 experimental group students. We examined intervention day training time effects when holding those data at 1,200 seconds and when truncating all scores that exceeded 20-minutes on intervention day to 1,200 seconds; however, the analyses did not appreciably differ in either case. In addition, we examined intervention day training time effects when excluding the 16 cases recorded as “20+” and the results did not appreciably differ. The analyses presented were conducted on the intervention day training times holding only the 16 cases recorded as “20+” at 1,200 seconds.

The intervention group ran significantly faster (M = 907.19 s, SD = 229.47 s) than the control group (M = 982.24 s, SD = 215.16 s), $t(282) = -2.83$, $p = .005$, $d = .34$, 95% CI [-127.19, -22.91] (see Figure 1). This supported our prediction that recalling a motivational memory would influence students to run faster in training for the Bagel Challenge as the experimental group students ran approximately 75 seconds faster than control group students[2].

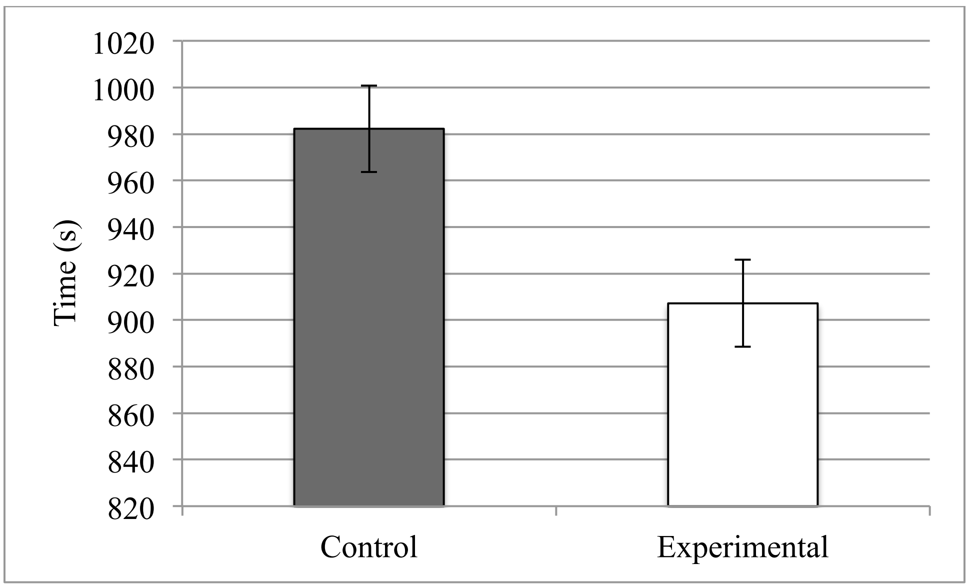

Figure 1. Observed training times on the day of the intervention in control and experimental groups.

Exploratory analyses of covariance were then performed examining the effect of the

2. A non-parametric Mann-Whitney U test produced similar results, as the intervention day training times were faster for those students in the intervention group (Mdn = 960.8) than those in the control group (Mdn = 1043), U = 7992.00, p = .003.

intervention on intervention day training times controlling for self-efficacy, and intrinsic motivation. In addition, a 2x2 and a 2x3 factorial analysis of covariance were performed to examine the effect of the intervention controlling for self-efficacy and intrinsic motivation with the addition of either sex or grade as factors. When controlling for intrinsic motivation and self-efficacy, the effect of the memory intervention was still evident, $F(1, 272) = 7.14$, $p = .008$, $\eta^2 = .026$. A post-hoc Tukey's LSD test showed that the estimated marginal mean training time of the experimental group (*M* = 903. 81 s, *SE* = 18.43 s) was less than the estimated marginal mean of the control group (*M* = 975.95 s, *SE* = 19.55 s), $p = .008$, 95% CI [-125.32, -18.98].

The addition of sex as a predictor of intervention day training time did not negate the effect of the memory intervention, $F(1, 266) = 5.58$, $p = .019$, $\eta^2 = .021$. Additionally, the interaction effect between sex and condition reached significance, $F(1, 266) = 3.96$, $p = .048$, $\eta^2 = .015$, which suggests the effect of the motivational memory was moderated by students' sex. A post-hoc Tukey's LSD test showed that the estimated marginal mean of the experimental group (*M* = 902. 58 s, *SE* = 18.27 s) was less than the estimated marginal mean of the control group (*M* = 966.33 s, *SE* = 19.76 s), $p = .019$, 95% CI [-116.92, -10.59] even when controlling for the effects of intrinsic motivation, self-efficacy, and sex. A post-hoc Tukey's LSD test of the sex-by-condition effect on training times suggested that motivational memory was most effective in females students as the estimated marginal mean training time of females in the experimental group (*M* = 897.34 s, *SE* = 26.06 s, 95% CI [846.03, 948.65]) was substantially lower than the estimated marginal mean of females in the control group (*M* = 1014.72 s, *SE* = 25.87 s, 95% CI [963.77, 1065.66]) (see Figure 2). The estimated marginal mean of male students was only slightly lower in the experimental group (*M* = 907.82 s, *SE* = 25.64 s) than in the control group (*M* = 917.95 s, *SE* = 30.14 s).

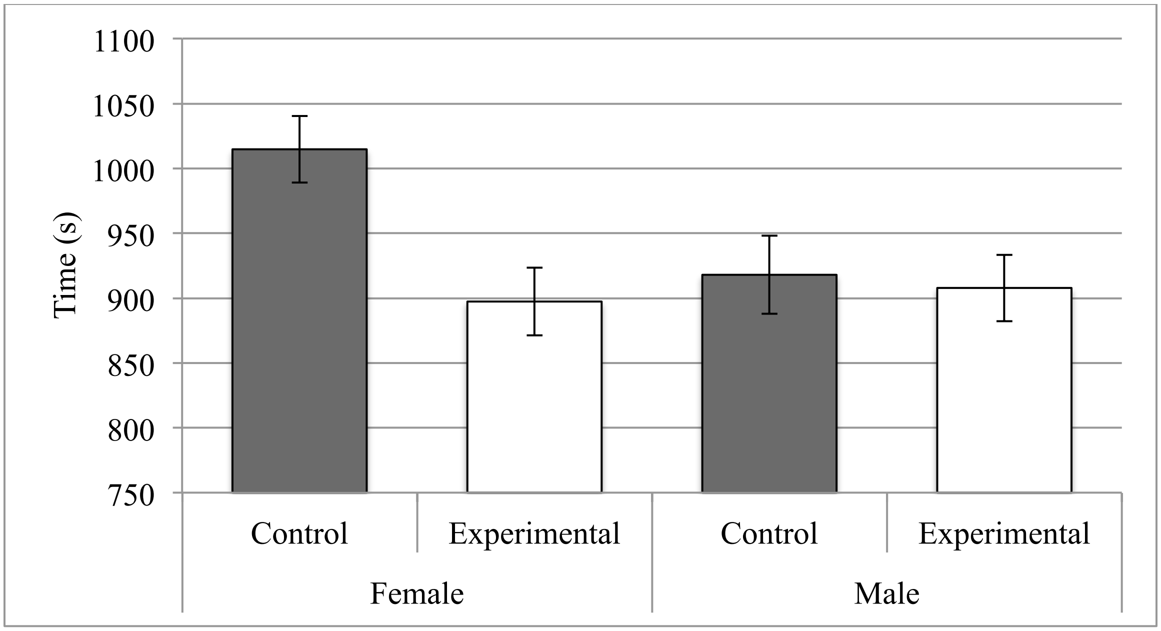

Figure 2. Sex-by-condition interaction in estimated training times on the day of the intervention for male and female students in control and experimental groups. Estimates shown when controlling for main effects of intrinsic motivation and self-efficacy.

Replacing the effect of sex for grade in a 2x3 condition-by-grade analysis of covariance with self-efficacy and intrinsic motivation as control variables did not negate the effect of the motivational memory on intervention day training times, $F(1, 268) = 10.78$, $p = .001$, $\eta^2 = .039$. A post-hoc Tukey's LSD test showed that the estimated marginal mean of the experimental group ($M = 908.79$ s, $SE = 16.41$ s) was less than the estimated marginal mean of the control group ($M = 988.47$ s, $SE = 17.70$ s), $p = .001$, 95% CI [-127.45, -31.89] even when controlling for the effect of grade. The interaction effect of grade and condition was not significant, $F(2, 268) = .28$, $p = .76$, $\eta^2 = .002$, which suggests the effect of the motivational memory was not moderated by students' grade.

Lastly, planned moderation analyses were performed to examine if the effect of the motivational memory intervention differed as a result of either self-efficacy or intrinsic motivation. For these analyses, self-efficacy and IMI scores were mean-centered and entered as control variables into an analysis of covariance with experimental condition as the between-student factor. The interaction terms of self-efficacy and IMI with experimental condition were added into the model in separate analyses. The interaction term of IMI scores and condition failed to reach significance; however the interaction term of self-efficacy with condition did reach significance, $F(1, 271) = 4.18$, $p = .042$, $\eta^2 = .015$. Parameter estimates suggested that for students in the experimental group, a one point increase in self-efficacy above the mean was related to a 73.09 second increase in running times, and a one point decrease in self-efficacy from the mean was related to a 73.09 second decrease in running time, $t(271) = 2.04$, $p = .042$, $\eta^2 = .015$, 95% CI [2.70, 143.49] (see Figure 3).

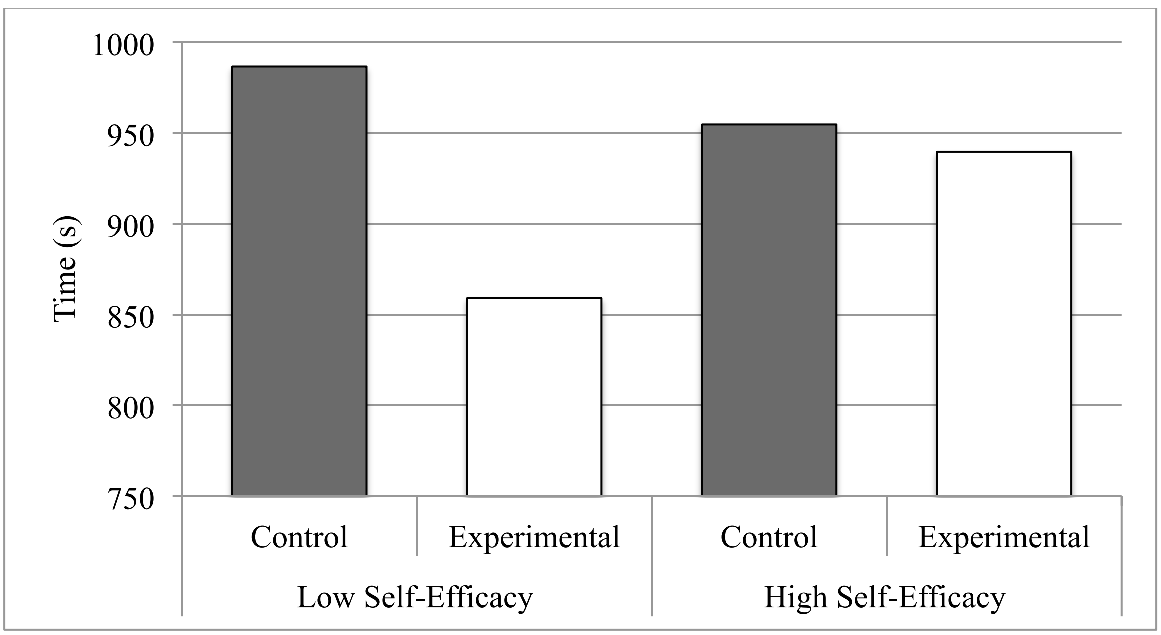

Figure 3. Self-efficacy-by-condition interaction on predicted intervention day training times. Estimates shown when controlling for main effects of intrinsic motivation and self-efficacy. Self-efficacy is held at +/- 1 SD from its grand-mean value for training time estimation for low and high self-efficacy participants.

This suggests that the motivational memory intervention improved running times to a greater extent for those students with lower levels of self-efficacy. Thus there is evidence that the effect of the motivational memory may have been moderated by self-efficacy such that its effect was greatest for those with lower self-efficacy.

These analyses suggest that the motivational memory did influence students to run faster on the day of the intervention. Furthermore, the effect was most pronounced for female students and students with lower levels of self-efficacy. Effects of the motivational memory intervention on students' training times will be further explored in the following section.

Multilevel Analysis

The use of MLM in analyses of intervention day training times allows us to examine if classrooms of students differed as a result of our randomization procedure in a way that may have affected results. As Wears (2002) explains, data from a cluster-randomized design, such as that employed in the current study, should not be analyzed in a normal linear regression format because cluster randomization violates the assumption of independence of observations. In randomizing students at the level of their classrooms, we know that students are nested within a classroom and their classroom is confounded with their intervention condition. This confound could explain any apparent differences in outcome variables. For example, students in each classroom may develop similarities over time that may not have existed prior to being in the same classroom. These commonalities between students in the same classroom can lead to inflated estimates of intervention effectiveness if we cannot quantify how classroom characteristics contribute to differences in outcomes.

MLM allows one to quantify classroom-level effects and to control for between-classroom and between-individual differences that could not otherwise be efficiently controlled for using multiple regression analysis. In MLM, the regression equation predicting any outcome variable from a set of predictor variables for an individual is composed of individual-level (between-student; level-1) regression intercepts and slopes and group-level (between-classroom; level-2) intercepts and slopes. Regression coefficients for any components of the regression equation that may differ as a function of the level-2 grouping variable can be estimated as random effects.

To analyze the classroom-level effects on intervention day training times, a multilevel regression analysis was performed similar to the ANCOVA used to examine intervention day training time effects, with the addition of intercepts that were allowed to vary between classrooms. In this analysis, there were only 12 classrooms of students represented at level-2. With only 12 units at level-2 of analysis, the ability to detect effects due to experimental assignment is compromised as the degrees of freedom used in estimating between-student differences due to experimental manipulation is determined by the level-2 units. According to Maas and Hox (2005), MLM analyses may overestimate variance components at level-2 with fewer than 30 groups; however, since this would mean overestimating the effect of the significance of classroom differences in determining training times, we reasoned that a failure to find such differences would be compelling support that differences in training time on intervention day were due to the intervention and not due to pre-existing differences.

The MLM of students' intervention day training times proceeded in the following sequence. First we fit an unconditional means-as-intercepts model that examined the amount of variance in intervention day training times attributable to differences between classrooms (Model A). Then we added the control variables of intrinsic motivation, self-efficacy, sex, and students' grades, which were entered as two dummy variables (Model B). Finally, we added the effect of the experimental intervention (Model C). Analyses were performed on SPSS using the MIXED procedure with restricted maximum likelihood estimation. Restricted maximum likelihood estimation is preferred over full maximum likelihood estimation in multilevel models with few level-2 units as it diminishes bias in the computation of variance components (Bickel, 2007; Maas & Hox, 2005).

MLM allows for the examination of random components of a model by estimating residual variance at the student-level and the classroom-level. The Wald-*z* significance tests for these estimates indicate the amount of variance remaining to be explained at either level of analysis. In addition, the intraclass correlation (ICC) was computed from these parameters to estimate the percentage of variance left at the classroom level as a function of total residual variance (ICC = Level-2 variance/(Level-1 variance + Level-2 variance). The existence of significant unexplained variance between-classrooms in the fully unconditional model (Model A) could suggest that effects attributed to the memory intervention in prior analyses may actually be due to pre-existing classroom differences. As students differed by grade in terms of self-reported physical activity and intentions to partake in voluntary physical activity, we reasoned that the addition of grade as a control variable in a 2-level model examining the effect of the memory manipulation on intervention day training times could account for much of the between-classroom variance. If the addition of grade as a between-student predictor decreased the unexplained level-2 variance without eliminating intervention effects, then we could argue that observed intervention effects were not a result of classroom differences.

The following is the equation for Model C, the 2-level model examining the motivational memory intervention’s effect on intervention day training times:

$$Y_{ij} = \gamma_{00} + \gamma_{01}Grade7_j + \gamma_{02}Grade8_j + \gamma_{10}SE\_C_{ij} + \gamma_{20}IM\_C_{ij} + \gamma_{30}Sex_{ij} + \gamma_{40}Condition_{ij} + \varepsilon_{ij} + \mu_{0j} \tag{1}$$

In this model, Y_{ij} is the training time for individual *i* on day *j* of training. The $Grade7_j$ variable is a dummy-coded variable represents being in grade 7 (*Grade 7* = 1; *Other* = 0). The $Grade8_j$ variable is a dummy-coded variable represents being in grade 8 (*Grade 8* = 1; *Other* = 0). The *SE_Cij* variable represents the grand-mean centered self-efficacy score for student *i* in group *j*. The *IM_Cij* variable represents the grand-mean centered IMI score for student *i* in group *j*. The Sex_{ij} variable represents the sex of the student (*Male* = 1; *Female* = 0). The $Condition_{ij}$ variable represents the experimental condition of the student. Mean-centering of the IMI and self-efficacy variables on the grand-mean of the sample allows us to consistently interpret results across students and classrooms. This leads to the following interpretation of regression coefficients: γ_{00} is the mean training time on intervention day for female students in the control group with average self-efficacy and average intrinsic motivation, γ_{01} represents the mean *difference* in intervention day training times for seventh-grade classes from the mean of the sixth-grade classes, γ_{02} represents the mean *difference* in intervention day training times for eighth-grade classes from the mean of the sixth-grade classes, γ_{10} is the *difference* in intervention day training times for all students for a one-unit change from the grand-mean value of self-efficacy, γ_{20} is the *difference* in intervention day training times for all students for a one-unit change from the grand-mean value of intrinsic motivation, γ_{30} is the mean *difference* from female students' intervention day training times for male students, and γ_{40} is mean *difference* from control group students' intervention day training times for experimental group students.

The random coefficients reflect variability in classroom mean training times as well as residual variance across all students and classrooms in training times. The level-1 residual, ε_{ij}, represents the variability in all students training times across classrooms. The level-2 random intercept, μ_{0j} allows classrooms to vary in their mean intervention day training times.

Model C results can be found in Appendix A. The analyses revealed that classroom differences did not contribute significantly to the effects observed in prior analyses. Although the classroom-level variance in Model A was significant, (*Estimate* = 16,399.99, *SE* = 7,636.00; *Wald-z* = 2.148, *p* = .032, 95% CI [6,584.39, 40,848.06], *ICC* = .32), the level-2 variance was no longer significant in Model C, (*Estimate* = 5,653.17, *SE* = 3,534.01; *Wald-z* = 1.60, *p* = .11, 95% CI [1,660.25, 19,249.10], *ICC* = .14). This means the predictors added into the MLM reduced the between-classroom variance in intervention day training times by 65% over Model A, and to a non-significant level.

As predicted, the limited power of the test diminished the ability to detect a significant intervention effect due to the inflated standard error and decreased degrees of freedom that are a result of MLM in such a small sample; however, the regression coefficient predicting training time from experimental condition was similar in absolute magnitude to our prior analyses, *b* = -69.84 s, *t*(8.475) = -1.42, *p* = .192, 95% CI [-182.48, 42.79].

This shows that controlling for classroom effects through the highly conservative use of MLM, the intervention effect is similar in magnitude. Most importantly, this analysis shows that the control variables used in the prior ANCOVA eliminated between-classroom differences that could explain intervention effects.

Race Day

To examine the effect of the experimental memory intervention on students' running times on the day of the intervention, we first compared the running times of the two groups. On race day, the intervention group ran slightly faster (M = 973.36 s, SD = 350.02 s) than the control group (M = 1005.12 s, SD = 351.14 s); however this difference was not significant, $t(243) = -.71$, $p = .479$, $d = .09$, 95% CI [-120.02, 56.50]. As all eighth-grade students elected to run in the costume heat and not in the heats organized according to speed of training runs and many seventh and eighth-grade students ran with the jazz band in the morning before the Bagel Challenge but not run in the heats organized according to training times, the Bagel Challenge race times were re-analyzed excluding costume heat runners (all eighth-grade students) and jazz band runners. Those in the experimental group who did not run the costume heat or with the jazz band ran faster (M = 815.09 s, SD = 266.29 s) than those in the control condition (M = 888.30 s, SD = 242.89 s); and this difference approached significance, $t(154) = -1.79$, $p = .075$, $d = .29$, 95% CI [-153.88, 7.44].

Additional analyses explored the effects of sex and grade on the students' running times. We ran two 2x2 factorial ANOVAs, one examining the effects of grade (sixth and seventh grade only) and intervention group on race day times, the other examining the effects of sex and intervention group on race day times. For both of these analyses, the costume heat and jazz band runners were excluded. In the analysis of sex and condition on race day run times, the main effect of sex was significant, $F(1, 149) = 13.08$, $p < .001$, $\eta^2_p = .081$, and the main effect of condition approached significance, $F(1, 149) = 2.86$, $p = .093$, $\eta^2_p = .019$. The interaction of sex and condition was not significant, $F(1, 149) = 0.21$, $p = .65$, $\eta^2_p = .001$. Post-hoc Tukey's LSD tests showed that the estimated marginal mean of the experimental group (M = 813.34 s, SE =

29.55 s) was lower than that of control group (*M* = 881.04 s, *SE* = 26.95 s), $p = .093$, 95% CI [-146.73, 11.34]. Post-hoc Tukey's LSD tests also showed that the estimated marginal mean of male students (*M* = 774.85 s, *SE* = 28.71 s) was significantly lower than that of female students (*M* = 919.52 s, *SE* = 27.85 s), $p < .001$, 95% CI [-223.71, -65.63]. In the analysis of grade and condition on race day run times, neither grade, condition, nor the interaction of grade and condition reached significance, (for the full model predicting race day times from grade and condition, $F(3, 149) = 1.20$, $p = .31$, $\eta^2_p = .023$).

As a final analysis of race day times, the data were re-analyzed using analysis of covariance on race day running times with condition as the between-student factor and controlling for intrinsic motivation and self-efficacy. These variables were controlled due to the a priori differences in self-efficacy between groups and the differences in intrinsic motivation that approached significance. The addition of these control variables slightly decreased the magnitude of the effect of condition, but did not change the pattern of results. Intrinsic motivation was a significant predictor of race day running times, $F(1, 149) = 6.24$, $p = .014$, $\eta^2_p = .04$. The effect of condition no longer approached significance, $F(1, 149) = 2.36$, $p = .13$, $\eta^2_p = .016$; however, a Tukey's LSD test revealed the absolute magnitude of the predicted difference between groups did not change greatly with the addition of the motivational and self-efficacy covariates. The predicted marginal mean of the experimental group (*M* = 822.53 s, *SE* = 29.92 s) was still lower than that of the control group (*M* = 885.14 s, *SE* = 27.46 s), $p = .127$, 95% CI [-143.13, 17.92]. Finally, terms representing the interactions of condition with self-efficacy and with intrinsic motivation were added to the model but were not significant and did not change the pattern of results regarding the effect of the intervention.

These analyses suggest that the effect of the motivational memory intervention was still present, even if mildly, at race day. Although males maintained their advantage in running time on the day of the Bagel Challenge, the effect of the memory intervention did not depend upon students' sex. After eliminating those students who did not run in the competitive race heats, there was no effect of grade; however, the elimination of those students restricted the remaining sample to sixth and seventh-grade students only. We also did not find evidence of moderation of the effect of the experimental memory intervention through self-efficacy or intrinsic motivation.

Therefore, we found limited support for our hypothesis that students recalling a motivational physical activity memory would run faster on race day. In conjunction with prior analyses showing the marked effect of the experimental intervention on students' intervention day training times, the analyses on race day times seem to suggest a sustained effect of the intervention that extends from the training context to the performance context.

Post-Race Day Questionnaires

In the three days following the Bagel Challenge, a subset of students representing each grade-condition pairing responded to a short questionnaire that asked a final time about their self-reported physical activity, about their enjoyment of running the Bagel Challenge, whether or not they achieved their goals at the Bagel Challenge, and whether or not they thought about the memory they gave for the intervention during the Bagel Challenge. We examined whether any effects could be detected on these variables as a result of the motivational memory intervention.

First, we analyzed self-reported physical activity for this subset of students who completed assessments after running the Bagel Challenge race. At this time, the control group reported more physical activity ($M = 3.45$, $SD = 1.15$) than the experimental group ($M = 3.36$, $SD = 1.22$); however, this difference was not significant, $t(139) = -.44$, $p = .66$, $d = .08$, 95% CI

[-.49, .31]. It should be noted that analyses of the physical activity self-report data taken following the Bagel Challenge includes the day of the race itself, which students may or may not have included in their self-report.

The analysis of students' reported enjoyment of the Bagel Challenge included only those students who had a recorded Bagel Challenge run time. The experimental group reported significantly more enjoyment (M = 3.03, SD = 1.23) than did the control group (M = 2.46, SD = .89), $t(112) = 2.85$, $p = .005$, $d = .53$, 95% CI [.17, .97]. Exploratory, follow-up 2x2 and 2x3 analyses of variance were run with condition and either sex or grade as factors to examine if the effect of the manipulation on students' enjoyment of the Bagel Challenge differed according to these factors. The addition of sex and or grade as a factor did not change the effect of condition, and the interaction effects did not reach significance. Therefore the impact of the motivational memory intervention on enjoyment of the Bagel Challenge did not differ by sex or grade of student.

Analyses examined if students in the experimental group more often reported either using the memory during the Bagel Challenge or having met their goals during the Bagel Challenge. Students did not differ as a function of intervention group on attaining their goals during the Bagel Challenge, $X^2(1, N = 114) = 1.13$, $p = .289$. A majority of students indicated that they attained their goals if they were in the experimental group (60%) or the control group (70%).

In terms of thinking about their memory during the Bagel Challenge, a greater proportion of students in the experimental group (22%) than in the control group (12%) reported thinking about the memory they gave for the intervention during the Bagel Challenge; however, this difference was not significant $X^2(1, N = 114) = 2.03$, $p = .154$. Still, the finding that 22% of intervention group students completing the follow-up questionnaire reported thinking about the memory is meaningful in that the intervention included a one-time prompt to recall a motivational physical activity memory and the suggestion the memory may be used to motivate oneself, generally speaking. The finding that 12% of control group students recalled their academic memory during the race is interesting. Although it could indicate that some students found a memory of academics helpful in motivating themselves to run, a more likely explanation is that students lacked the metacognitive awareness to reliably assess how and when they use memories and erroneously recalled thinking of their memory during the race. In our prior research (Biondolillo & Pillemer, 2015), many college-age students reported using a memory they had written about for motivation when they had not written about a memory at all. It appears more likely that people of all ages find it difficult to report about their use of memory.

These findings provide limited evidence that the simple suggestion that a memory may be used to motivate could have influenced some students to self-regulate the use of their memory in a performance context several weeks removed from originally recalling the memory.

To further explore the effects of thinking about the memory on students' experience at the Bagel Challenge, we split the data by intervention group and examined the effect of recalling the memory at the Bagel Challenge on students' enjoyment of the Bagel Challenge and on their running times. In addition we examined the relation between recalling the memory and goal attainment at the Bagel Challenge in control and experimental groups separately.

Thinking about the intervention memory during the Bagel Challenge did not have an impact on Bagel Challenge running times in either the control, $t(57) = -1.36$, $p = .179$, $d = .36$, 95% CI [-461.05, 87.99], or the experimental group, $t(53) = -0.65$, $p = .52$, $d = .18$, 95% CI [-325.50, 166.73]. For enjoyment of the Bagel Challenge, there was a trend towards significance in the control group such that those reporting having recalled their memory reported greater enjoyment ($M = 3.00$, $SD = 1.08$) than those reporting not having recalled their memory ($M = 2.38$, $SD = .85$), $t(57) = 1.74$, $p = .087$, $d = .46$, 95% CI [.09, 1.32]. In the experimental group, those students who reported recalling their motivational memory reported greater enjoyment of the Bagel Challenge ($M = 3.83$, $SD = 1.40$) than those who reported not recalling their motivational memory ($M = 2.80$, $SD = 1.09$), $t(53) = 2.72$, $p = .009$, $d = .75$, 95% CI [.27, 1.79]. We did not have large enough cell sizes to examine if using the memory at the Bagel Challenge was related to goal attainment.

These follow-up data provide tentative findings about the subset of students who completed the post-race questionnaire. As in prior analyses, there was no effect on self-reported physical activity, which is not surprising, as one would not anticipate a latent effect several weeks removed from such a brief intervention. Goal attainment at the Bagel Challenge was also not related to the intervention. This too was not a surprise as students were never asked to set a goal and many students wrote on their questionnaires that they never had a goal in mind. We did find that students in both conditions reported using memories during the Bagel Challenge. The number reporting memory use, though small, is still meaningful in that it provides an indication that at least some students were able to regulate the use of motivational memories to help them perform during the race.

The most interesting finding was that students in the experimental group reported greater enjoyment of the Bagel Challenge than students in the control group. This is noteworthy because the Bagel Challenge was the first time since training that students were grouped by ability and not by classroom in running the course. Also, the Bagel Challenge was more of a performance context than the training runs during which the pressure to compete was minimal. Finally, the results suggest that enjoyment of the Bagel Challenge was related to students' use of motivational memory during the race. Control group students' use of memories was not as predictive of enjoyment of the Bagel Challenge. These results will be addressed further in the conclusions.

The following section will examine the effect of the experimental intervention in fifth grade classrooms as these classrooms underwent the experimental procedure under inconsistent environmental conditions that differed considerably from those encountered by other students.

Fifth-Grade Classrooms

In the dataset comprised uniquely of fifth-grade students, we repeated all analyses on main outcome variables. First, we examined pre-intervention background variables for between-group equivalence. Then we examined intentions to partake in optional physical activity. Finally we looked at the effect of the intervention on intentions in males and females separately.

Analyses were run on IMI scores, self-efficacy, and pre-intervention self-reported physical activity with intervention condition as the between-student factor and again with sex as the between-student factor. The analyses failed to show any significant differences as a result of intervention condition; however, males and females differed in pre-intervention self-reported activity, $t(106) = 2.87$, $p = .005$, $d = .56$, 95% CI [.96, .18]. Males in fifth grade reported more physical activity ($M = 4.41$, $SD = .76$) prior to the intervention than did females ($M = 3.84$, $SD = 1.14$).

Next we examined the relation between experimental condition and intentions to partake in optional afterschool physical activity. As in the analyses in older students, we combined the "Yes, I'm interested and I plan on going" responses with the "Yes, I'm interested but I won't be able to go" responses. The relation between experimental condition and intentions was significant, $X^2(1, N = 114) = 6.59$, $p = .01$. Fifth-grade students in the experimental condition more often reported they were interested in attending (77%) and less often reported they were not at all interested (23%) than did control group fifth-grade students (For “Yes, I’m interested and I plan on going,” and “Yes, I’m interested but I won’t be able to go,” 54%; for, “No, I’m not interested in going,” 46%). Therefore our hypothesis that giving a motivational physical activity memory would influence students’ intentions to partake in optional physical activity was supported in the fifth-grade classrooms.

Analyses of sex differences in the intentions-intervention relation showed that the effect observed in fifth grade was almost entirely driven by female students. For fifth-grade females, the relation between intervention condition and intentions was significant, $X^2(1, N = 65) = 7.006$, $p = .008$, and the same effect in male students was not, $X^2(1, N = 48) = 0.94$, $p = .33$. Fifth-grade females in the experimental condition more often respond that they planned on going or that they would like to but couldn’t attend (82%), and less often reported not being interested (18%) than did control group females (for “Yes, I’m interested and I plan on going,” and “Yes, I’m interested but I won’t be able to go,” 52%; for “No, I’m not interested in going,” 48%). Fifth-grade male students’ responses did not vary appreciably as a function of intervention condition. (In experimental and control groups respectively: “Yes, I’m interested and I plan on going,” and “Yes, I’m interested but I won’t be able to go,” 70% versus 56%; “No, I’m not interested in going,” 30% versus 44%).

The effect of the intervention on students’ self-reported physical activity in the week following the memory intervention was examined. The intervention group reported more physical activity ($M = 3.85$, $SD = 1.25$) than did the control group ($M = 3.64$, $SD = 1.37$); however, the difference was not significant, $t(99) = .82$, $p = .42$, $d = .16$, 95% CI [-0.73, 0.31].

A series of analyses of covariance were performed examining the effect of condition on self-reported physical activity following the intervention controlling for pre-intervention self-reported physical activity, self-efficacy, and IMI scores. In addition, a 2x2 factorial analysis of covariance was performed to examine the effect of condition on self-reported physical activity with the same control variables and the addition of sex as a between-student factor. These exploratory analyses also failed to show an effect of condition either as a main effect or in interaction with sex.

Lastly, planned moderation analyses were performed to examine if the effect of the intervention might be detectable in interaction with self-efficacy or intrinsic motivation. The interaction terms of condition with intrinsic motivation and with self-efficacy failed to reach significance in analyses of self-reported physical activity at either time point following the intervention, thus providing no evidence of moderation through either of these two background variables.

Therefore analyses of self-reported physical activity in fifth-grade students, like the analyses with older students, did not support our prediction that the memory intervention would influence self-reported physical activity.

The effect of the intervention on students' objectively measured training times immediately following the memory intervention was examined. The control group ran faster (M = 727.56 s, SD = 199.03 s) than the experimental group (M = 777.05 s, SD = 200.79 s); however, this difference was not significant $t(110) = 1.31$, $p = .19$, $d = .25$, 95% CI [-25.40, 124.38].

Exploratory analyses of covariance were then performed examining the effect of the intervention on intervention day training times controlling for self-efficacy, and intrinsic motivation. In addition, a 2x2 factorial analysis of covariance was performed to examine the effect of the intervention on self-reported physical activity with the control variables of self-efficacy and intrinsic motivation and the addition of sex as a between-student factor. When controlling for intrinsic motivation and self-efficacy, there was still no effect of the memory evident, $F(1, 105) = 2.22$, $p = .14$, $\eta^2 = .021$. A post-hoc Tukey's LSD test showed that the estimated marginal mean of the experimental group (M = 780.62 s, SE = 24.45 s) was greater than the estimated marginal mean of the control group (M = 728.33 s, SE = 25.13 s), $p = .14$, 95% CI [-17.23, 121.83]. With the addition of sex as a predictor of intervention day training time, the main effect of the memory intervention still was not significant, $F(1, 102) = 1.83$, $p = .18$, $\eta^2 = .018$; however, the main effect of sex was significant, $F(1, 102) = 4.63$, $p = .034$, $\eta^2 = .043$. The interaction effect between sex and condition was not significant, $F(1, 102) = 0.54$, $p = .46$, $\eta^2 = .005$. A post-hoc Tukey's LSD test showed that the estimated marginal mean of the experimental group (M = 769.78 s, SE = 24.66 s) was greater than the estimated marginal mean of the control group (M = 721.91 s, SE = 25.31 s), $p = .18$, 95% CI [-22.23, 117.97] when controlling for the effects of intrinsic motivation, self-efficacy, and sex. A post-hoc Tukey's LSD test of the main effect of sex showed that the estimated marginal mean running time of male students was significantly faster (M = 707.23 s, SE = 27.41 s) than was that of females (M = 784.46 s, SE = 22.74 s), $p = .034$, 95% CI [-148.41, -6.07].

Planned moderation analyses were then performed to examine if the effect of the motivational memory intervention differed as a result of either self-efficacy or intrinsic motivation. For these analyses, self-efficacy and IMI scores were mean-centered and entered as control variables into an analysis of covariance with experimental condition as the between-student factor. The interaction terms of self-efficacy and IMI with experimental condition were added into the model in separate analyses. The interaction terms of IMI scores and condition as well as self-efficacy and condition failed to reach significance in their respective analyses.

These analyses suggest that the motivational memory did not consistently influence fifth-grade students to run faster on the day of the intervention. We reiterate that the collection of data in fifth grade classes was highly variable across classes as three of the four classes ran their intervention day a full week after one of the experimental groups. Furthermore, the one experimental group that ran the intervention day run did so in the extreme heat that the sixth-through-eighth-grade classes faced and ran a separate course than the other three fifth-grade classes.

To examine the effect of the experimental memory intervention on fifth-grade students' running times on the day of the Bagel Challenge, we first compared the running times of experimental and control groups. At the Bagel Challenge, the intervention group ran slightly slower (M = 736.91 s, SD = 196.66 s) than the control group (M =721.89 s, SD = 204.02 s); however, this difference was not significant, $t(105) = 0.39$, $p = .79$, $d = .08$, 95% CI [-61.82, 91.85]. As in prior analyses, we wanted to explore the effects of sex on fifth-grade students' running times. We ran a 2x2 factorial ANOVA examining the effects of sex and intervention group on race day times. The main effect of sex was significant, $F(1, 102) = 14.74$, $p < .001$, $\eta^2_p = .126$, but neither the main effect of condition, $F(1, 102) = 0.16$, $p = .69$, $\eta^2_p = .002$, nor the interaction of sex and condition, $F(1, 102) = 0.17$, $p = .68$, $\eta^2_p = .002$, reached significance.

As a final analysis of race day times, the data were re-analyzed using analysis of covariance on race day running times with condition as the between-student factor and controlling for intrinsic motivation and self-efficacy. The addition of these control variables slightly increased the magnitude of the effect of condition, but did not change the pattern of results. Intrinsic motivation was the only significant predictor of race day running times, $F(1, 99) = 9.89$, $p = .002$, $\eta^2_p = .091$. The effect of condition still was not significant, $F(1, 99) = 0.54$, $p = .47$, $\eta^2_p = .005$. Finally, terms representing the interactions of condition with self-efficacy and with intrinsic motivation were added to the model, but neither interaction term was significant and the addition of the interaction terms did not change the pattern of results regarding the effect of condition.

For data collected after the Bagel Challenge, independent samples *t*-tests were run on the self-reported physical activity measure and the enjoyment of the Bagel Challenge measure for the subset of students who completed follow-up assessments. Again, the experimental group reported more physical activity ($M = 4.08$, $SD = 1.12$) than the control group ($M = 3.83$, $SD = 1.20$); however, this difference was not significant, $t(35) = -.61$, $p = .55$, $d = .21$, 95% CI [-1.06, 0.58]. In terms of their enjoyment of the Bagel Challenge, experimental group fifth-grade students reported greater enjoyment ($M = 3.71$, $SD = 1.20$) than those in the control group ($M = 3.15$, $SD = 1.28$); however, this too was not significant, $t(34) = 1.27$, $p = .213$, $d = .44$, 95% CI [-.34, 1.46]. With such a small sample size of fifth-grade students it would have been difficult to find statistically significant differences in these measures. Still, it is interesting that they follow the same pattern as results in the sixth through eighth-grade students.

Finally, we examined the relation between goal attainment during the Bagel Challenge and thinking of the intervention memory. There were no differences in goal attainment as a function of experimental condition, $X^2(1, N = 36) = 0.06$, $p = .813$. Nearly the same proportion of fifth-grade students in the experimental condition reported attaining their goals during the Bagel Challenge (50%) as those in the control condition (54%). For use of memory during the Bagel Challenge, a significantly greater proportion of fifth-grade students in the experimental condition reported using their memory (75%) than in the control condition (29%), $X^2(1, N = 36) = 6.81$, $p = .009$. This may reflect veritable memory use, but with so few students reporting it would be premature to make this conclusion. Still, it does suggest that students even as young as fifth grade may benefit from the one-time prompt to use a motivational memory to self-regulate physical activity behavior many days later.

In general, the effect of the intervention was muted in the fifth-grade classrooms in comparison to the older students' classrooms. The biggest difference between groups was in terms of intentions to be physically active and in enjoyment of the Bagel Challenge; however, there was no discernable effect in self-reported physical activity or measured run times. As mentioned previously, one of the fifth-grade experimental groups had their intervention on an exceptionally warm day and all other fifth-grade classrooms ran on a different course the day of their intervention, which was performed on a cooler day a week later than the other classrooms. Furthermore, low sample size limits the power of any test to find discernable effects in fifth-grade students' follow-up data. Additional developmental explanations for the absence of a motivational memory effect in fifth-grade students will be explored in the discussion section.

Positive Emotion

To thoroughly examine the effect of the intervention, the between-group difference in the positive affect of memories evoked by the experimental and control prompts had to be investigated as a possible explanation for the observed memory effects. Analyses of the effect of the memory intervention on self-reported physical activity, training times, and race times were run with the addition of students' positive affect reports as a control variable. Memory affect ratings, though higher in the experimental condition, were highly positive in both conditions as the majority of students in the control and experimental groups rated their memories as very or extremely positive (44% very, and 43% extremely positive memories in control condition; 27% very, and 68% extremely positive memories in experimental condition). Due to this ceiling effect and the restricted range of the measure (the measure was a 1-5 scale), a transformation to normalize the distribution of this measure was not possible. In order to make interpretation of any effects tied to memory affect more meaningful, we dichotomized the measure into "positive affect rating of 1-4" (coded as 0) and "positive affect rating of 5" (coded as 1). We investigated the effects of memory ratings both as this dichotomized variable and as a grand-mean centered continuous variable. We also added interaction effects of mean-centered positive affect and the terms representing experimental effects. In examination of intentions to be physically active, we looked at the relation between condition and intentions separately in students with a positive affect rating of five and those with a positive affect rating less than five. In all analyses, the addition of the positive affect variable did not change the pattern of results and did not negate any significant intervention effects previously detected.

One interesting finding came from analysis of intervention day running times in sixth through eighth-grade students. When mean-centered positive affect and the interaction between mean-centered positive affect and condition were entered as covariates in the ANCOVA predicting intervention day times from condition, self-efficacy, and intrinsic motivation, the interaction effect of positive affect and condition was significant, $F(1, 268) = 4.11$, $p = .044$, $\eta^2_p = .015$; however, this did not account for the main effect of experimental condition, which remained significant, $F(1, 268) = 5.09$, $p = .025$, $\eta^2_p = .019$. Parameter estimates were requested and indicated that a one-unit increase in positive affect over the grand-mean was associated with running 74.26 seconds faster for both experimental and control group students, 95% CI [-131.82, -16.70]; however, in the experimental group an increase of one unit in positive affect associated with memory over the grand-mean accounted for a 94.94-second slowing on intervention day run times, 95% CI [2.75, 187.12]. Adding these parameters together, a one-unit increase in positive affect over the grand-mean was associated with running about 74-seconds faster in the control group, but about 21-seconds slower in the experimental group. Results were similar when the analysis was run as a 2x2 factorial ANOVA with positive emotions as a dichotomized factor.

Thus the affect associated with the memory mattered very little in experimental group students, which is not surprising considering the ceiling effect in those students, but the more positive the control group memory, the better their performance on intervention day. As indicated by the significant main effect of condition, this interaction effect did not account for a significant portion of the motivational memory effects on running times.

Fifth-grade students did not have as great a difference in positive affect of memory between conditions as the older students, $t(112) = 1.78$, $p = .079$, $d = .34$, 95% CI [-.09, .35], but the experimental group still did have memories that were more positive ($M = 4.25$, $SD = .43$) than those of the control group ($M = 4.09$, $SD = .56$) so we also examined the effect of positive affect in fifth-grade students as well. There were no effects on outcome variables attributable to positive affect of memory whether tested as a dichotomous or as a continuous predictor.

Therefore, we did not find evidence that the differences between the experimental and control groups were a result of differences in the positive emotions elicited by the memory prompts.

DISCUSSION

This study examined whether recalling a past positive motivational memory of physical activity would increase middle school students' intentions to partake in voluntary physical activity, self-reported physical activity, objectively measured physical activity as indicated by attendance at an optional afterschool physical activity session, and objectively measured physical activity as measured by training times in preparation for a race and in times run at the race. As predicted, students who gave a positive motivational memory during one physical education class reported significantly greater intentions to attend an optional physical activity session than students in the control group who gave a positive semantic memory pertaining to school. In further support of our hypotheses, students giving the positive motivational memory ran their training run faster than control group students immediately after the intervention and this effect was evident when controlling for self-efficacy for physical activity, intrinsic motivation for physical activity, student sex, and student grade. Furthermore, the intervention was effective even though students were running in extreme heat on intervention day. In partial support of our hypotheses, students in the experimental group who ran in competitive heats during the Bagel Challenge tended to run faster than control group students, but the effect was somewhat weak. Contrary to hypotheses, motivational memory did not have an impact on self-reported physical activity and did not impact students' attendance at an afterschool physical activity. The effects of the motivational memory intervention were not a result of classroom characteristics or of the positive emotions elicited by the memories.

This study supports prior research and theory on the directive effect of autobiographical memory (Biondolillo & Pillemer, 2015; Kuwabara & Pillemer, 2010; Phillipe et al., 2013;

Pezdek & Salim, 2011; Selimbegović, Régner, Sanitioso, & Huguet, 2011) and advances our knowledge of the effect of memory on objectively measured behavior, also showing that memories can direct behaviors in adolescence. Additionally, this study adds to a growing body of research that examines the use of autobiographical memory as a motivational tool for behavior change and maintenance (Biondolillo & Pillemer, 2015; Selimbegović et al., 2011; Selimbegović, Régner, Huguet, & Chatard, 2015). Our results suggest that behavior change interventions can be aided by the use of one's own memories as a store of motivational content. In everyday life, our memories may implicitly influence our behavior, and the prompt to think of a memory may tap into the otherwise automatic influence of autobiographical memory. Traditional behavior change interventions may benefit from the inclusion of training in memory-based self-regulation strategies for activity initiation or maintenance.

Although it is possible that the relatively greater positive affect of the motivational physical activity memory could explain the performance of experimental group students, this explanation seems unlikely. We controlled for the positive affect of memory in all analyses and this did not change the pattern of results with regard to the effects of the experimental manipulation. Although the interaction of positive affect with experimental condition significantly predicted training times on intervention day for the older students, this effect did not eliminate the main effect of experimental condition. Furthermore, the relation of intentions and experimental condition did not differ as a function of memory affect ratings, and the addition of positive affect ratings also did not change the pattern of results for Bagel Challenge running times. Therefore, the evidence does not suggest that differences in students affective feeling states following memory recall explain the observed differences in training times.

It is possible that students in the experimental condition changed their behavior because they inferred that the intent of the researcher was to influence physical activity; however, this explanation seems unlikely. Both the intervention and control groups filled out background questionnaires regarding their physical activity prior to and following the intervention and were alerted to our interest in this variable; if students inferred researchers intended to influence their physical activity we would not expect the inference to have differentially impacted the groups. Also, the students' physical education teachers were blind to assignment. Although the principal investigator became un-blinded in the course of data collection, his interaction with students was minimal and consisted primarily of instructing students to fill out research questionnaires. He was not included in performing training runs, with their timing, or with their recording. On rare occasions he would assist with the setup and cleanup of materials used in physical education classes when it was necessary to allow time for students to complete questionnaires. It is highly unlikely that this contact systematically differed between experimental and control groups. The only difference in the treatment of the two groups was the type of memory students were asked to recall on intervention day, so any differences in behavior ought to have been as a result of the experimental manipulation.

This study suggests that the physical activity benefits from recalling a positive motivational physical activity memory may have been moderated by pre-existing self-efficacy but not by intrinsic motivation. Self-efficacy is a theoretically relevant predictor of physical activity through which prior interventions have endeavored to affect behavior (Bandura, 2004; Chatzisarantis & Hagger, 2009; Parschau, et al., 2012; Plotnikoff et al., 2013; Sutton, 2008). It is encouraging that the memory intervention most benefitted students who were least confident in their abilities to perform physical activities in this sample, and this finding suggests the use of memory may be most helpful for those who are lacking in confidence to moderate their physical activity.

Unfortunately, we were not able to examine if the effects observed were mediated through post-intervention measurement of any variable. This was due to the limited amount of time we were allowed with students at any given data collection point, which hindered us from collecting follow-up measures of intrinsic motivation and self-efficacy. Future naturalistic studies in adolescent populations could examine the impact of memory interventions on self-efficacy, motivation, attitudes, and other social-cognitive variables through which the intervention might affect activity. Our prior research did not find evidence of mediation of the effect of memory on self-reported physical activity through motivation, affect, or general attitudes towards physical activity in a college sample (Biondolillo & Pillemer, 2015); however, the addition of self-efficacy as a mediating variable was not examined. The addition of a post-intervention measure of self-efficacy could have helped explain the effect of motivational memories on behavior in the current study.

Evidence from prior studies suggests that directive memory effects may not be attributable to purposeful mneumonic activities and may instead result from implicit processes (Biondolillo & Pillemer, 2015; Kuwabara & Pillemer, 2010); however, instructions to participants in those studies did not suggest that the memory be used in any particular way. The current study included a suggestion that the memory could be used as motivation. It is possible that the prompt influenced participants to purposefully utilize the memory to achieve better training times and race times. The evidence of a lingering effect on running times the day of the Bagel Challenge suggests that students were able to continue to benefit from the memory long after they were prompted to recall the memory initially, which suggests the one-time prompt and suggestion may have influenced some students to purposefully use their memories as a self-regulatory strategy. Furthermore, many students reported using their memories during the Bagel Challenge in order to motivate themselves, which suggests that some students were able to use memories as an effortful self-regulatory mechanism even without explicit instruction at that time.

Another explanation for how memories may impact behavior comes from Pezdek and Salim (2011) who proposed that recalling autobiographical memories may prime relevant aspects of the self-concept, which in turn influences subsequent behaviors. In the present study, recalling a positive motivational memory may have primed a positive view of the self in regards to physical activity, which increased intentions for physical activity and subsequent behaviors. These activated positive feelings and intentions could have led to the significant differences in physical activity following the intervention without the necessity of purposefully revisiting the memory. Following the Bagel Challenge, students in the motivational memory group reported greater enjoyment of the Bagel Challenge than control group students, indicating a more positive view of self in relation to physical activity. Future studies could examine memory's impact on adolescent self-concept and examine if repeated explicit prompting of the use of memory may result in greater and longer-lasting effects.

Alternatively, Selimbegović and colleagues (2011) suggest that general, but not specific, positive memories may lead to better performance of a cognitive task. Although the prompts used in the present study asked for episodic detail, we also asked for memories framed as "positive motivational memories." The use of these terms in prompting for a specific memory may prompt for an exemplar memory that primes more generally positive views of the self than those prompted by specific memory cues in similar studies (Selimbegović et al., 2011; Selimbegović et al., 2015). Additionally, the behavior we examined was physical activity and not a cognitive task, such as those examined by Selimbegović et al. (2015). In future studies, the wording used to prompt a specific memory may be varied to examine more specifically how an episodic memory affects behavior. Likewise, future studies could examine if specific autobiographical memories differentially impact performance on cognitive and physical tasks.

The differential impact of the memory on the performance of male and female students is difficult to disentangle and may be a facet of the particular sample studied rather than a reflection of normative developmental processes. In this study, males generally did not see an immediate benefit to recounting a motivational memory, whereas females did. Females might benefit more from the intervention as they generally have lower levels of physical activity (Van der Horst et al., 2007), and developmental research suggests females have better, and earlier-developing autobiographical memory (Fivush & Nelson, 2004), which suggests they could more easily benefit from the activation of memories during adolescence. Although males in the sample had overall better performance on measures of physical activity, which is consistent with prior studies (e.g., Trost et al., 2002), the impact of the memory intervention on males' physical activity was negligible. It could be that males were not able to benefit from a memory intervention to influence an ability for which they were already highly motivated and at which they performed better relative to same-age female peers. Alternatively, males may be less likely to benefit from the use of autobiographical memories as motivation. The effects of memory use on behaviors in adolescent males demand further exploration.

As for grade effects, this study showed the same decline in physical activity behavior as noted in prior research over the course of adolescence (Brownson et al., 2005; Sallis et al., 2000; Trost et al., 2002), as fifth-and-sixth-grade students reported more activity and performed better in training than all other grades of students, and the eighth-grade students performed the worst.

The effect of the intervention, on the other hand, did not seem to differ according to grade. This suggests that the use of motivational physical activity memories may be useful for adolescents already experiencing a decline in physical activity to help mitigate declines regardless of their age. Of course, longitudinal research coupled with explicit prompting and rehearsal of the motivational memory would be able to more clearly demonstrate if the use of motivational memories can help inhibit declines in physical activity altogether or if they are more effective in improving levels of physical activity after the occurrence of a decline.

The fifth-grade classes did not seem to benefit from the intervention to the same extent as older students; however, in our sample of fifth-grade students there were many confounds that corresponded with the administration of the experimental procedure and leave the null findings questionable. Fifth-grade students may require more explicit prompting or instruction in memory use, as their memory and metacognitive abilities may not be mature enough to benefit from such an innocuous intervention. On the other hand, confounds present during experimental manipulation may have obscured memory effects. Future research should examine if more explicit prompting or instruction in the use of memory to regulate motivation would benefit students in fifth-grade or in even younger samples.

The effect of remembering a prior positive motivational physical activity memory on physical activity was evident despite the modest scope of the intervention and the adverse environmental conditions faced by most students on the day of the intervention. Although experimental control was forfeited by employing a naturalistic design, this adds to the ecological validity of our findings. In a physical education scenario faced by students on a weekly basis, the one-time prompt for a motivational physical activity memory was found to benefit objectively measured physical activity. The students sampled were not actively seeking behavior change, they were already receiving external rewards that were given by physical activity teachers for improvement in running times, and the day of the intervention was exceptionally hot; still students in the experimental condition ran faster than those in the control condition.

This study has several limitations. First, the sample consisted of predominantly Caucasian students in a relatively affluent community. In addition, the majority of the students already participated in some form of structured physical activity in the school. The physical education teachers mentioned that the many students were members of the cross-country running team and other sports. We attempted to identify students who were highly physically active outside of school with a background question regarding afterschool activities; however, students reported myriad after school activities, including many routine activities such as doing homework and eating dinner, which indicated that students interpreted this question in many different ways. We decided to forgo analysis based on the number or type of activities reported due to this apparent confusion. Therefore, the results should be replicated in more heterogeneous samples, including adolescents who are actively seeking to increase their physical activity or who are identified as low physical activity or at risk for obesity. A more complete measure of afterschool physical activities could also help identify those students for whom the intervention may work better.

A second limitation is that the motivational memory did not appear to affect self-reported physical activity or actual attendance at an optional physical activity session. Given our past research with college students (Biondolillo & Pillemer, 2015), it was surprising not to find an effect of the intervention on self-reported activity. One reason may be that, due to time constraints faced in data collection, the self-report measure was cut from the whole PAQ-C, which has been validated in similar-aged samples, to a single item from the measure. This allowed us to attain self-reported physical activity data during class time; however, there was much confusion about how to respond to the item due to the brevity of the measure. In looking through students' self-reports, it was apparent that some students did not read through all answer choices before responding and other students checked all answer choices; these reports were scored at the highest level. In future studies, a more thorough self-report measure of physical activity should be used, and the administration of the self-report measure should be done with comprehensive instruction.

Developmentally, it may have also been difficult for students, especially the younger students, to read the prompt with the brief instructions given, to think about their activity over the prior seven days, to read all the answer choices, and to select the single most appropriate answer. The metacognitive and working memory abilities needed to answer such a question in the distracting setting of a physical education class may not have been mature enough in some students. Although many students had no difficulty reading and responding to all written measures, more time and more thorough instruction should bolster the reliability and validity of self-reported physical activity data collected in a similar sample.

The design of the study made control of the timing of the intervention difficult as many classes had field trips and other activities that interfered with their normal physical activity classes. This led to vastly different conditions in three out of four of the fifth-grade classrooms on intervention day. We dealt with this problem by analyzing the data from fifth grade separately; however, this further limits the generalizability of findings. We could not determine if the smaller effects noted in fifth-grade classrooms was a result of the inability of fifth-grade students to utilize the memory or if it was due to the inconsistent intervention day environments.

Future studies could try an experimental intervention in a controlled experimental setting in order to better equate the conditions on intervention day.

As for the null finding regarding attendance at the afterschool physical activity session, many of the students already had a full afterschool schedule or may not have had the autonomy to choose to stay after school for the physical activity session. Initially, the researchers had wanted to have the optional physical activity session during the school day, but this was not possible. Another option considered was to give the option to be physically active or not during physical education classes, but the teachers did not want to allow students to be sedentary during class time. Ultimately, the best option was to offer an afterschool activity. Researchers made attempts to give reminders about the activity through in-class announcements, announcements over the P.A. system, and flyers posted around the school, but only three students attended the session. Future research examining students' choices about physical activity in a naturalistic setting should attempt to find an optional activity that most students can attend if they so desire.

Finally, the measurement of race day running times was of questionable reliability as school personnel were understandably more concerned with the safety and whereabouts of students during the race than on the timing of each heat, and students were not concerned enough with their race times to consistently monitor their times as they finished. This led to a communication error on race day that compromised the reliability of race day timing, especially for the students who ran more slowly. The measurement error did not appear to favor one condition over another, but we cannot know for certain which students' race times were invalid. Future research using a performance measure such as race times may want to invest in automatic timing systems like magnetic running bibs.

In conclusion, this study adds to the growing body of research examining memory’s directive influence in practical domains of behavior. In addition, it assessed memory’s effect in a naturalistic setting in a sample of adolescents. The results suggest that memories of past experiences can and do affect objective real-world behaviors, even with a minimal prompt. In addition, the effects noted on physical activity are encouraging, as interventions for physical activity are in need of novel strategies that can be paired with traditional practices to improve physical activity and support long-term maintenance of behavior change. Furthermore, the results indicate that cognitive self-regulation strategies can be effectively used by adolescents who are in the process of forming an identity and establishing consistent physical activity patterns. Our hope is that the present research will inspire additional efforts to bridge the gap between health behavior change research and cognitive models of behavioral regulation and lead to innovative, practical techniques for individuals to use in their efforts to improve their well-being.

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APPENDIX A

TABLES

		Parameter	Model A		Model B		Model C	
Fixed Effects			Estimate	SE	Estimate	SE	Estimate	SE
Fixed Effects	*Intercept*	γ_{00}	949.83***	38.76	842.64***	45.86	877.32***	50.05
	Self-Efficacy	γ_{10}			17.95	21.87	19.3	21.88
	Intrinsic Motivation	γ_{20}			-36.98*	15.35	-37.08*	15.34
	Sex	γ_{30}			-34.72	22.99	-33.67	23
	Condition	γ_{40}					-69.84	49.32
	Grade 7	γ_{01}			119.96~	63.03	119.15~	59.66
	Grade 8	γ_{02}			243.37**	63.81	244.98**	60.48
Variance Components								
Level-1	Within-Classroom	ε_{ij}	34993.76***	3033.58	34206.16***	3014.66	34208.88***	3014.66
Level-2	Between-Classroom	μ_{0j}	16399.99*	7636	6479.67~	3715.12	5653.17	3534.01
% Reduction within-classroom variance					2.25		2.24	
% Reduction between-classroom variance					60.49		65.53	
Goodness-of-fit								
	Deviance		3716.816		3574.361		3562.78	
	AIC		3720.816		3578.361		3566.78	
	BIC		3728.064		3585.528		3573.94	

~ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Note: Restricted ML, SPSS MIXED

Table 2. Table of coefficients from multilevel models of student's intervention day training time controlling for intrinsic motivation, self-efficacy, sex, and grade.

APPENDIX B

MULTILEVEL MODEL OF CHANGE IN TRAINING TIME

In addition to its use in analyzing individual and group-level effects in a nested dataset, MLM also allows for the modeling of growth curves, or the modeling of change over time when there are repeated measures. In the present study, students' training times were measured on numerous occasions and with varying intervals between measurement occasions. MLM allows us to compute regression equations to predict between-student differences in training time as a result of any student-level variables. These between-student differences are used to estimate the grand mean of training time across all measurement occasions (level-2 intercept) and the average effect of individual differences across all measurement occasions (level-2 slopes). These student-level estimates are added into a composite equation that includes within-student estimates of the average initial training time at the start of data collection (level-1 intercept) and average daily rate of change across all students (level-1 slope).

Using MLM in this way you can consider the effect of time to be nested within individuals, as each individual has several measurement occasions over time. Individual differences (such as sex) can be added to level-2 equations for between-student differences (level-2 slopes), and time-varying predictors, such as the introduction of the intervention, can be entered into the composite equation to compute changes in the initial status and rate of change bound to time-varying predictors (level-1 slopes and intercepts). When MLM is applied in this way, coefficient estimates from random within-student effects can give us an idea of the between-student variability remaining to be explained in initial status and rate of change and the residual variance that remains over measurement occasion.

To prepare the data for MLM of change, the dataset was transformed into a person-period dataset wherein the data of each student was represented in several rows, one for each measurement occasion. A variable representing the number of days between each measurement occasion was added and centered on May 4, 2015, the first day of training for any classroom. This allowed for the level-1 intercept to have a meaningful interpretation, a student's estimated training time at the beginning of training (May 4th), and the effect of measurement occasion (level-1 slope for time) could then be interpreted as the daily rate of change in training time. Between-student predictors of interest (self-efficacy, intrinsic motivation, and positive affect of memory) were centered on the grand-mean of the sample for ease of interpretation and for moderation analyses.

Deviance statistics were requested to indicate model fit. Nested models were compared using the general linear hypothesis test, which compares the change in deviance statistics between two nested models on a chi-square distribution with degrees of freedom equal to the difference in parameters estimated between the models (Bickel, 2007). For example, for a model with an increase of one parameter estimate over a prior model, the -2 log likelihood ratio deviance statistic would need to decrease by greater than 3.84 for the more complex model to be retained.

Models were tested by adding predictors to an unconditional 2-level linear growth model (Model A) as fixed effects. First self-efficacy and intrinsic motivation were added as control variables (Model B). Then, all intervention effects were added including post-intervention daily rate of change (Model C). We added the effect of the intervention last to examine if its addition improved model fit and if the regression coefficients for intervention effects were significant. In all models the level-1 intercept and the level-1 slope for the effect of time were estimated as random effects. The following equation was our a priori 2-level model to examine the intervention's effect on change in training times (level-1) and the relationships between students' characteristics and their rate of change (level-2)[3]:

$$Y_{ij} = \gamma_{00} + \gamma_{01}SE\_C_i + \gamma_{02}IM\_C_i + \gamma_{10}Time_{ij} + \gamma_{20}Intervention_{ij} + \gamma_{21}Condition_i * Intervention_{ij} + \gamma_{30}Time\_Post_{ij} + \gamma_{31}Condition_i * Time\_Post_{ij} + \varepsilon_{ij} + \zeta_{0i} + \zeta_{1i}Time_{ij} \qquad (2)$$

Y_{ij} is the training time for individual i on day j of training. The SE_Ci variable represents the grand-mean centered self-efficacy score for student i. The IM_Ci variable represents the grand-mean centered IMI score for student i. The $Time_{ij}$ variable represents the daily rate of change in training time for student i at day j (centered on May 4th). The variable, $Intervention_{ij}$, represents the introduction of the intervention for student i on day j. The $Condition_i$ variable represents the group into which student i was assigned (control group = 0; experimental group = 1). The $Time\_Post_{ij}$ variable represents the change in daily rate of change in training time for student i of group j after the introduction of the intervention (For each student, this variable is 0 through intervention day and then accrues in accordance with the number of days since intervention day).

3. Prior to fitting models in the pre-determined order, condition was added as a predictor of both initial training time on May 4th and of pre-intervention rate of change to examine if groups behaved equivalently. There were no group differences noted prior to the intervention so the effects were not included in the model so that intervention effects would only be examined from the point of randomization.

Mean-centering of the IMI and self-efficacy variables on the grand-mean of the sample allows us to consistently interpret results across measurement occasions and across students. Likewise centering of the variable representing time on the beginning of the training period within the school allows for a consistent interpretation of coefficients obtained, including for the intercept term. This leads to the following interpretation of regression coefficients: γ_{00} is the initial training time for participants with average self-efficacy and average intrinsic motivation on May 4th, γ_{01} is the *difference* in initial status for all students for a one-unit change from the grand-mean value of self-efficacy, γ_{02} is the *difference* in initial status for all participants for a one-unit change from the grand-mean value of intrinsic motivation, γ_{10} is the average within-person daily rate of change in training time prior to the intervention, γ_{20} is the *difference* in predicted training time following the intervention for the control group, γ_{21} is the *difference* in predicted training time following the intervention for the experimental group, γ_{30} is the *difference* in within-person daily rate of change from the pre-intervention rate of change following the intervention for students in the control condition, and γ_{31} is the *difference* in within-person daily rate of change from the pre-intervention rate of change following the intervention for students in the experimental condition.

The random coefficients reflect variability in the initial training time and rate of change between-students as well as residual variance across all students and measurement occasions. The level-one residual, ε_{ij}, represents the daily variability in training time across measurement occasions and students. The level-two random intercept, ζ_{0i}, and random slope, ζ_{1i}, allow students to vary in their initial training time (their intercept) and their daily rates of change in training times (level-1 slope). Results can be found in Table 3.

		Parameter	Model A		Model B		Model C	
Fixed Effects			Estimate	SE	Estimate	SE	Estimate	SE
Initial Status	*Intercept*	γ_{00}	875.53***	11.75	870.64***	11.43	876.10***	12.79
	Self-Efficacy	γ_{01}			4.72	18.48	6.68	18.38
	Intrinsic Motivation	γ_{02}			-43.28**	13.06	-43.91**	12.99
Rate of Change	*Intercept*	γ_{10}	0.57~	0.33	0.57~	0.33	-1.64~	0.91
	Intervention	γ_{20}					119.29***	17.71
	*Intervention*Condition*	γ_{21}					-48.53**	16.63
	Post-Time	γ_{30}					-6.33***	1.56
	*Post-Time*Condition*	γ_{31}					4.01*	1.76
Variance Components								
Level-1	Within-student	ε_{ij}	15322.72***	804.02	15322.02***	805.16	13746.43***	728.44
Level-2	In initial status	ζ_0	27547.26***	3420.06	24752.99***	3211.73	25612.13***	3192.71
	In rate of change	ζ_1	2.01	2.74	2.11	2.74	4.85~	2.76
	Change covariance	ζ_{01}	-8.94	76.06	15.57	73.53	-31.01*	73.99
Goodness-of-fit								
	Deviance		16582.541		16472.895		16392.751	
	AIC		16594.541		16488.895		16416.751	
	BIC		16625.45		16530.062		16478.503	

~ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$
Note: Full ML, SPSS MIXED

Table 3. Table of coefficients from multilevel models of student's change in training time controlling for intrinsic motivation and self-efficacy.

Results from Table 3 revealed a trend in the daily rate of change in training time such that students' training times were estimate to decrease by 1.64 seconds every day ($p = .071$, 95% CI [-3.42, 0.14]). Whereas there was no effect on training time attributable to self-efficacy, students' training times were estimated to decrease by 43.91 seconds for every one-unit increase in intrinsic motivation above the mean value ($p = .001$, 95% CI [-69.48, -18.35]). The memory intervention also had an impact on training time both immediately on intervention day, and as an influence on the daily rate of change in training time following the intervention. Students in the control condition were estimated to experience an immediate increase in their training times of 119.29 seconds ($p < .000$, 95% CI [84.54, 154.05]). This estimate was likely influenced by the exceptionally warm temperatures on intervention day. Following the intervention, control group students experienced a more precipitous daily decrease in their training times as their post-intervention daily change in training time was estimated to be 6.33 seconds faster than their pre-intervention rate of change ($p < .000$, 95% CI [-9.40, -3.26]). Experimental group students were also estimated to slow following the intervention but by 48.53 seconds less than the control group ($p = .004$, 95% CI [-81.17, -15.88]); however, they experienced a slower daily decrease in training times following the intervention as their post-intervention daily decrease in training time was estimated to be 4.01 second less than control group students ($p = .023$, 95% CI [0.55, 7.46]), meaning control group students were estimated to decline more rapidly than experimental group students following the intervention.

Overall, the MLM suggests the positive motivational physical activity memory was effective at motivating students to run faster in training than the academic control memory. This effect was robust to the extreme heat experienced the days of the intervention resulting in an approximate two-minute slowing in training times for students in the control condition, which was lessened by approximately 49 seconds for experimental group students. This disparity diminished through subsequent training runs. The relation between training time and experimental condition from Model C is depicted in Figure 4. These results should be interpreted with caution as the training courses prior to the intervention differed from those used on intervention day, and due to the aforementioned adverse weather conditions on intervention day.

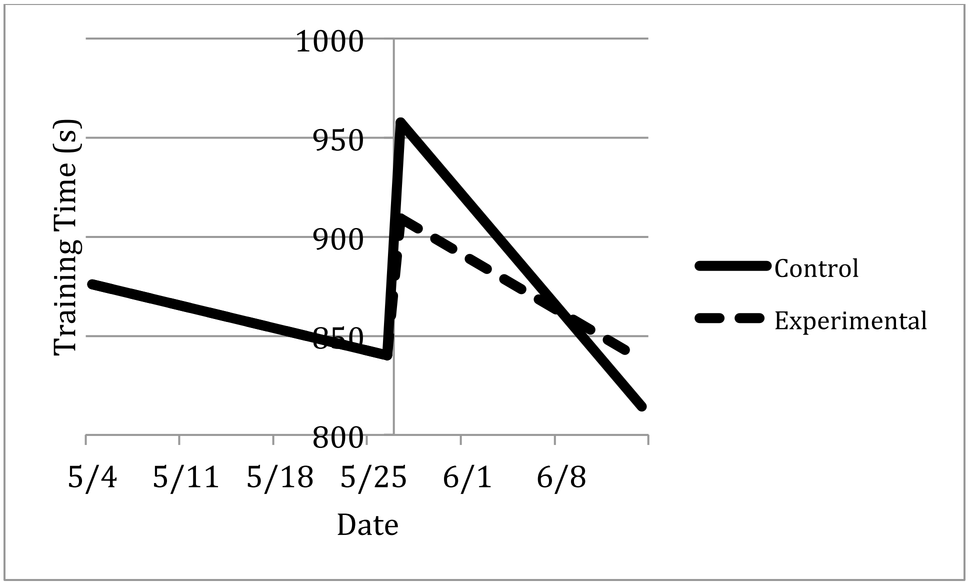

Figure 4. Predicted training times for control and experimental group students according to MLM analysis of change. Vertical axis represents date of intervention.

APPENDIX C

STUDY DOCUMENTS

IRB Approval Letter

University *of* New Hampshire

Research Integrity Services, Service Building
51 College Road, Durham, NH 03824-3585
Fax: 603-862-3564

04-May-2015

Biondolillo, Mathew
Psychology, McConnell Hall
15 Academic Way
Durham, NH 03824

IRB #: 6246
Study: Promoting Physical Activity in Adolesence
Approval Date: 30-Apr-2015

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved the protocol for your study as Expedited as described in Title 45, Code of Federal Regulations (CFR), Part 46, Subsection 110.

Approval is granted to conduct your study as described in your protocol for one year from the approval date above. At the end of the approval period, you will be asked to submit a report with regard to the involvement of human subjects in this study. If your study is still active, you may request an extension of IRB approval.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the attached document, *Responsibilities of Directors of Research Studies Involving Human Subjects.* (This document is also available at http://unh.edu/research/irb-application-resources.) Please read this document carefully before commencing your work involving human subjects.

If you have questions or concerns about your study or this approval, please feel free to contact me at 603-862-2003 or Julie.simpson@unh.edu. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Director

cc: File
Pillemer, David

Parental Consent Form

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Parent/Guardian Consent

An Invitation: We understand that you are the parent or guardian of a student at Oyster River Middle School. This student is invited to participate in a study of physical activity motivation. The research is being conducted by Mathew Biondolillo from the University of New Hampshire under the supervision of Dr. David Pillemer, Dr. Samuel E. Paul professor of developmental psychology at the University of New Hampshire. The study has been endorsed by Principal, Jay Richard, and will be conducted in collaboration with staff and administrators from Oyster River Middle School. Mathew is a 4th year graduate student of developmental psychology and instructor of psychology at the University of New Hampshire. Mathew has published on memory and motivation in undergraduate students.

Please read this form for information about this study, and for instructions on how to withdraw your child. If you do not want your child to participate in the study, you must notify your school by signing and returning this form by May 11, 2015.

Purpose: The purpose of this study is to investigate how middle school students use memories of past experiences in order to maintain motivation for physical activity. We do not work for Oyster River Middle School. Your child will be asked to fill out several questionnaires as part of this study. These questionnaires will be administered over the course of six weeks starting in early May. In addition, as preparation for the Bagel Challenge in June, students will be running a training course in their Physical Education classes on a weekly basis, and their times run during the training runs and during the Bagel Challenge itself will be shared with researchers. We will also provide an opportunity for your child to partake in one optional physical activity session after school, supervised by Physical Education faculty. Your child's responses on questionnaires and times run will be combined with approximately 600 other students from your child's school.

Description of the Study: From early May until mid-June, your child will be asked to:

- Complete questionnaires once a week for four weeks. Each questionnaire will take about 10 minutes to complete and will be done during the school day in Physical Education classes.
- Your child will also be asked to fill out questionnaires regarding their motivation for physical activity, memories of physical activity or academic experiences, their self-efficacy for physical activity (how confident they feel they could find time for physical activities), and to report about their physical activity over the span of one week.
- Share their times run on a training course as part of their Physical Education curriculum in the five weeks leading up to the Bagel Challenge. Your child will also be asked to share their time run during the Bagel Challenge as they finish the race.
- All students will be offered the opportunity to participate in an optional after school physical activity session involving light cardio and stretching that will be supervised by Physical Education faculty. Your child's attendance at this session would be used as study data.
- Your child will participate in these activities during Physical Education classes. Your child will not leave or miss class to participate in this project. If you do not want your child to participate, or your child decides not to participate, a Physical Education instructor will work with your child to identify an alternative activity that he or she can do during the questionnaires.

Voluntary Participation and Right to Withdraw: Participation in the study is voluntary. You have the right to refuse to allow your child to participate in this study and the right to withdraw your child from the study at any time. Your child has the right to withdraw from the study at any time, including the right to stop at any point during the questionnaires or any physical activity. There is no penalty for refusal or withdrawal, and refusing to allow your child to participate or withdrawing their participation will not impact their participation in class activities. Your child also has the right to refuse to answer any questions in the questionnaires.

Confidentiality: The researcher plans to keep your child's responses confidential and private. However, there are rare times when others may be able to see research data (e.g., if your child discloses information about harm to self or others; if there is suspected child abuse and/or neglect). In these instances, researchers are required to report this information to government and/or law enforcement officials and required to notify a school official. Also, the University of New Hampshire Institutional Review Board can have access to data in some cases (e.g., if a participant filed a complaint), but your child will not be identified personally. Your child's responses will be reported as groups, but may be reported as

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individual cases when quotations are used. In presentations and publications, participants' responses may be used in the form of quotations, but no names or other identifying information will be included. All of your child's data will be coded and stored as a number, not by their name and surveys will be de-identified as soon as all data are coded. In publications that result from this research, your child will not be identified by name. All surveys, notes, and records will be kept in a locked room in either a cabinet or on a secured computer in Dr. Pillemer's research lab at the University of New Hampshire.

Potential Benefits: Benefits of participation include the opportunity to participate in and contribute to physical activity and memory research that aims to improve the motivation to be physically active in middle school students.

Potential Risks: There are minimal foreseeable risks for your child participating in this study. These may include physical discomfort involved with participating in the optional session of voluntary physical activity that will be offered to all students; however, this will be supervised by Physical Education faculty and will involve activities commonly performed in Physical Education classes.

Compensation: If you do not refuse to allow your child to participate and if your child elects to participate in this research, he or she will be entered into a raffle for one of ten $20 Amazon gift cards. Withdrawing participation after beginning the study will not affect your child's eligibility for this raffle.

Future Questions and Concerns: The University of New Hampshire's Institutional Review Board for the Protection of Human Subjects in Research has approved the use of human subjects in this study. If you have any questions about this research project or would like more information before, during, or after the study, you may contact Mathew Biondolillo by phone (716-983-5975) or email (mjbiondolillo@gmail.com). If you have questions about your child's rights as a research subject, you may contact Dr. Julie Simpson in UNH Research Integrity Services at 603-862-2003 or Julie.Simpson@unh.edu to discuss them.

If you do not want your child to participate, this form must be returned to your child's Physical Education teacher by May 11, 2015. If you wish for your child to participate, you do not need to do anything. If you do not return this form, your child will be given the option to participate in all parts of the study, although he or she may decline to participate.

Withdrawal Form

By returning this form, I ***do not give permission*** for my child to partake in this study:

____
Child's Name

______________________________ ______________
Legal Guardian Signature Date

____
Printed Name

Participant Assent Form

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You're Invited to Take Part in the Physical Activity Motivation Study!

(Assent for Students 10-14)

You are invited you to take part in "The Physical Activity Motivation Study". The research is being done by Mathew Biondolillo from the University of New Hampshire, along with teachers and staff at your school. This study is not being done as part of your classwork or as part of any school-sponsored program.

What is the study? We are doing this study to understand what motivates middle school students for physical activity. The researchers do not work for Oyster River Middle School. In your Physical Education class over the next 4 weeks, you will be asked to answer questions about yourself and your physical activities. We also ask you to share with us the times you run during training for the Bagel Challenge and at the Bagel Challenge itself and to answer a few questions about the Bagel Challenge after you've run it. You will also have an opportunity to attend one optional physical activity session after school, supervised by a Physical Education teacher and your attendance at this session will be used as study data. All students in your school also have the opportunity to be a part of this study. Participation in this study is expected to present minimal risk to you. Participation in this study may benefit you by providing knowledge about your own motivation for physical activity and about the process of doing research.

Do you have to do the study? You can decide if you want to be in the study or not. You don't have to be in the study, and if you do not want to be in the study, nothing will happen and you will not be in trouble. If you start the study, you can drop out at any time, you can stop answering questions during the survey or stop sharing your running times at any time. Refusing to participate or withdrawing participation will not affect your participation in class activities or your grades.

Are your answers private? The researchers plan to keep what you say and answer private. When the researchers go to tell other researchers and teachers what they found, they will talk about what students said without using their names. In rare cases, others may be able to see research data (e.g., if you disclose information about harm to self or others; if you disclose suspected child abuse and/or neglect). In these instances, researchers are required to report this information to government and/or law enforcement officials and required to notify a school official.

What compensation is there for being in the study? If you decide to be in the study, you will be entered into a raffle and have a chance to win one of ten $20 Amazon gift cards. If you withdraw your participation, you will still be eligible to win a gift card.

What if you have a question? If you have any questions or would like more information before, during, or after the study, you can talk to Mathew while in class or contact him by email (mmn87@wildcats.unh.edu) afterwards.

ASSENT TO PARTICIPATE IN PHYSICAL ACTIVITY MOTIVATION STUDY

Sign below if: I have read and understood the information about the "Physical Activity Motivation Study." I understand that being in this study is completely my choice. I agree to be in this project. I understand that the information gathered is for research purposes and will be kept confidential by the researchers except under rare circumstances. I understand that I can stop being in the study at any time without getting in trouble.

____
Student's Name (please print)

________________________________ ________________
Student's Signature Date

Demographics Form

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1) What is your name? (Please Print)

____

2) Are you a male or a female? (Circle Male or Female)

Male Female

3) When were you born? (Month, Day, and Year)

____

4) What grade are you in?

_________ Grade

5) What is your race or ethnicity? (Put a check mark next to all that apply; if you do not know, you may check "Unsure")

_____ Caucasian/White
_____ African American/Black
_____ Asian/Pacific Islander
_____ Native American
_____ Other (Please Specify) _________
_____ Unsure

6) What afterschool activities do you regularly do? (please list below)

1. ____________________________
2. ____________________________
3. ____________________________
4. ____________________________
5. ____________________________

If you regularly do more than five activities afterschool you may write in the space below or on the back of this page.

Intrinsic Motivation Inventory

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We'd like to know how you feel about physical activity. Physical activity includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

For each of the following statements, please indicate how true it is for you using the following scale:

	1 Not at all true	2	3	4 Somewhat true	5	6	7 Very true
I enjoy physical activity very much	1	2	3	4	5	6	7
I think I am pretty good at physical activity	1	2	3	4	5	6	7
I believe I have some choice about physical activity	1	2	3	4	5	6	7
I think physical activity is a boring activity	1	2	3	4	5	6	7
I am pretty skilled at physical activity	1	2	3	4	5	6	7
I do physical activity because I have to	1	2	3	4	5	6	7
I think physical activity is quite enjoyable	1	2	3	4	5	6	7
I cannot do physical activity very well	1	2	3	4	5	6	7
Physical activity is fun to do	1	2	3	4	5	6	7
I do physical activity because I want to	1	2	3	4	5	6	7

Self-Efficacy Scale

University of New Hampshire

We want to know how you feel about being physically active. Being physically active includes participating in sports or dance that make you sweat or make your legs feel tired, or in games that make you breathe hard, like tag, skipping, running, climbing, and others.

Please read each statement and circle the number indicating how much you agree with each statement. The higher the number you circle, the more you are saying you agree with each statement. Circling 1 means you disagree a lot with the statement, and circling 5 means you agree a lot with the statement.

1. I can be physically active during my free time on most days.

1	2	3	4	5
Disagree a lot				Agree a lot

2. I can ask my parent or other adult to do physically active things with me.

1	2	3	4	5
Disagree a lot				Agree a lot

3. I can be physically active during my free time on most days even if I could watch TV or play video games instead.

1	2	3	4	5
Disagree a lot				Agree a lot

4. I can be physically active during my free time on most days even if it is very hot or cold outside.

1	2	3	4	5
Disagree a lot				Agree a lot

5. I can ask my best friend to be physically active with me during my free time on most days.

1	2	3	4	5
Disagree a lot				Agree a lot

6. I can be physically active during my free time on most days even if I have to stay at home.

1	2	3	4	5
Disagree a lot				Agree a lot

7. I have the coordination I need to be physically active during my free time on most days.

1	2	3	4	5
Disagree a lot				Agree a lot

8. I can be physically active during my free time on most days no matter how busy my day is.

1	2	3	4	5
Disagree a lot				Agree a lot

PAC- Question for Self-Reported Physical Activity

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Name_______________________________

We are trying to find out about your level of physical activity from ***the last 7 days*** (in the last week). This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

Remember:

1) There are no right or wrong answers – this is not a test.
2) Please answer the question as honestly and accurately as you can – this is very important.

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1. Which *one* of the following describes you best for the last 7 days? Read *all five* statements before deciding on the *one* answer that describes you.

A. All or most of my free time was spent doing things that involve little physical effort.. ☐

B. I sometimes (1 — 2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics)............... ☐

C. I often (3 — 4 times last week) did physical things in my free time.................. ☐

D. I quite often (5 — 6 times last week) did physical things in my free time......... ☐

E. I very often (7 or more times last week) did physical things in my free time.... ☐

Experimental Memory Prompt

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Name____________________________ Date_________

Sometimes people feel like they want to be physically active and other times they don't. In order to get motivated to be physically active, some people find it useful to think about a **positive past experience**.

In the space below, please write about a specific experience from any time in your life when you did something physically active and felt especially **good about yourself**. This experience should be a **MOTIVATIONAL MEMORY**, a memory you would think about when you feel you want to be physically active. Your memory should be about a **positive experience** that happened at a particular time and place. I'd like to know where you were, what you did, how you felt, and any other details about your positive physical activity experience.

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You can think about this memory to get motivated to be physically active any time you want!
1. Please circle the word or face that describes how good you felt about yourself during the experience you wrote about:

How good did you feel about yourself when you did the physical activity you wrote about?

Not at all	A little	Somewhat	Quite a bit	A lot
1	*2*	*3*	*4*	*5*

2. In the gym after school next week, there will be an optional short (30 minute) physical activity session that could help you prepare for the Bagel Challenge. Would you be interested in attending this afterschool physical activity session? (Circle one)

A. Yes I'm interested and I plan on going............................ ☐

B. Yes I'm interested but I won't be able to go.................. ☐

C. No I'm not interested in going.. ☐

Control Memory Prompt

University of New Hampshire

Name____________________________ Date_________

Sometimes people like to think about their favorite subject to study in school and other times they don't. In order to do well in school, some people find it useful to think about their favorite subject to study in school.

In the space below, please write about your favorite subject to study in school.

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1. Please circle the word or face that describes how much you like the school subject you wrote about:

How much do you like the school subject you wrote about?

Not at all	A little	Somewhat	Quite a bit	A lot
1	*2*	*3*	*4*	*5*

2. In the gym after school next week, there will be an optional short (30 minute) physical activity session that could help you prepare for the Bagel Challenge. Would you be interested in attending this afterschool physical activity session? (Circle one)

A. Yes I'm interested and I plan on going........................ ☐

B. Yes I'm interested but I won't be able to go.................. ☐

C. No I'm not interested in going.................................. ☐

APPENDIX D

AFTERSCHOOL PHYSICAL ACTIVITY FLYER

Fun and Fitness Afterschool in the Gym

TODAY!

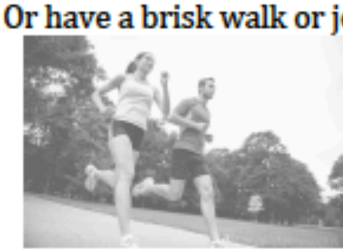
2:30 – 4:00 pm

Come and join your friends and fellow classmates for some fun and games in the gym or outside.

Come have a ball

Or have a 'bee

Or have a brisk walk or jog



It's up to you!

Late bus available

APPENDIX E

SCHEDULE OF ASSESSMENTS

Study Week	Dates	Assessments
1	May 11 – 15	Assent Demographics Intrinsic Motivation Inventory Self-Efficacy Measure Training Time
2	May 18 – 22	Physical Activity Self-Report Measure Training Time
3	May 25 – 29	Intervention or Control Prompt Intention to Attend Optional Physical Activity Session Training Time
4	June 1 – 5	Physical Activity Self-Report Time 2 Training Time Attendance at Optional Physical Activity Session
5	June 8 – 12	Training Time No written assessments scheduled but assessments may be given if missed in prior weeks
6	June 15 – 19	Bagel Challenge Race Time Follow-Up Physical Activity Self-Report Measure Follow-Up Self-Efficacy Measure Questions About Bagel Challenge Experience